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BRITISH BEES.—III.

By FRED. ENOCK, F.L.S., F.E.S., etc.

IT is only when we come to examine the burrows of leaf-cutter bees and dissect the newly formed cells, that we begin to realize the marvellous ingenuity displayed in their construction. We find that generally the foundation is formed of a circular piece of leaf, which the bee has so rammed down that it fits into the rounded end of the

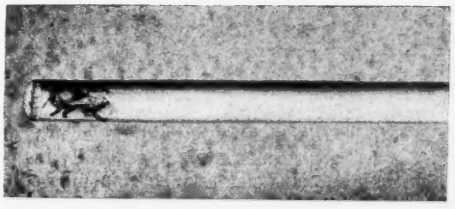


FIG. 12.—Foundation of First Cell.

burrow (Fig. 12). The bee, having satisfied itself with its work so far, next proceeds to exhibit such high intelligence that we are bewildered with the thought, "Where does so-called instinct end and reasoning power begin?" The bee does not hesitate in its work, but as soon as the circular piece of leaf is fixed it seems to recognize in a moment that it would not do to attempt to form the sides of the cells of circular pieces; accordingly, without compasses or two-foot rule, or any other means of measurement than her unerring eye and powerful mandibles, in a few seconds she has cut an oblong wedge-shaped piece of leaf (Fig. 13), which she

FIG. 13.—First Side-piece cut and carried.

carries to her burrow, and, taking it down thin end first, carefully places that end in the saucer-shaped foundation (Fig. 14). Another oblong wedge-shaped piece of leaf is cut and carried home and down the burrow, and once more our "superior intellect" is humbled when we find that the bee shows still greater common sense in depositing the second piece than the first, for she so fits it that one edge just overlaps that of the first (Fig. 15). Another visit to the bush outside furnishes an exact counterpart of the first and second oblongs, fixed in the same methodical manner (Fig. 16); but still the circle is incomplete, and for the fourth

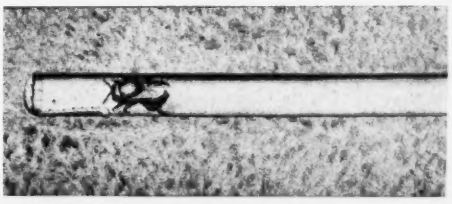


FIG. 14.—First Side-piece fixed in Position.

time the untiring architect leaves the nest for the stores, from which it again cuts an oblong, and as quickly returns to its burrow, and so carefully and correctly has it measured the circumference that this fourth piece fits in, just overlapping both the third and first pieces (Fig. 17). Owing to the wedge shape of these four pieces the cell is not by any means fit to receive the nectar and pollen for which it is intended. The bee still works on, cutting another oblong from a leaf, which she places exactly midway over the joint of the first and second (Fig. 18), and so on until she has completely closed every

opening at the sides. Sometimes she places an additional thickness both at the bottom and at the sides. The cell now is ready for the "pudding," and the bee goes out to gather the ingredients from the flowers—notably

Fig. 15.—Second Side-piece fixed.

those of the campanula. Having filled her reservoir with nectar and covered her body with pollen, she flies off to her burrow, and quickly divests herself of her load. Carefully brushing the pollen from her abdomen, and ejecting the nectar from her honey stomach, she proceeds to mix the two into a "pudding," to the best of her ability, so that it will not disagree with the stomachs of her

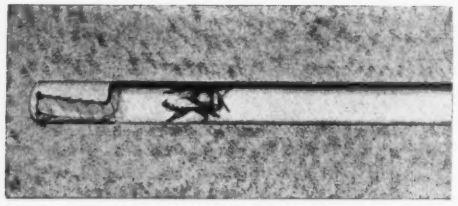


Fig. 16.—Third Side-piece fixed.

progeny. Many journeys are made before a sufficient supply is collected, and the cell filled to within a certain distance of the top. When this point is reached, the bee lays a single egg on the top of the pudding (Fig. 19). Having taken so much trouble to build up this wonderful cell, it is not surprising to find that she next proceeds to protect her property. She makes another journey to the bush, and cuts out a circular piece of leaf, which she fits into the cell so carefully that it does not press upon the delicate egg; and, to make assurance doubly sure, she not unfrequently places as many as a dozen of these circular covers superposed on each other, a short space being left from the last cover to the top edge. As soon as this first cell is finished and sealed up, she proceeds to build the second, the end of which fits into the first (Figs. 20 and 21).

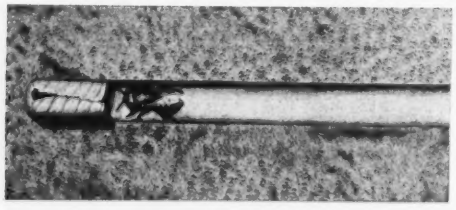


Fig. 17.—Fourth Side-piece fixed.

In this way the industrious bee continues her work as long as the sun continues to shine, until she has placed from nine to a dozen cells in her burrow, the entrance to which is then carefully closed with sand; a few broken bits of dead leaves and heather bells are scattered about, and no trace is left. Should the weather continue bright, the bee sinks another burrow, which she fills with cells, and sometimes she will make others before her energies are exhausted.

Other marvellous work lies hidden under the sand, but nature is carrying on her transformations. The eggs hatch into legless maggots, that find their food ready to their mouths (Fig. 22); a few weeks of such sweet food brings them to full growth, and they are ready for their next change—the chrysalis. Before that stage is reached, however, they

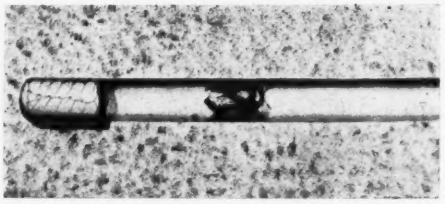


Fig. 18.—First Gap filled up.

spin themselves a silken shroud, and fastening the silk to the sides and ends they turn themselves round and rest upon their backs, with their heads pointing to the entrance of the burrow (Fig. 23). In this position they assume the chrysalis stage, in which they remain for at least a month. During this time the changes of colour and gradual forma-

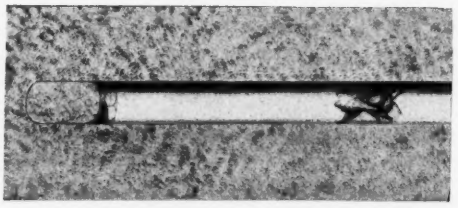


Fig. 19.—Section of First Cell, showing Pudding and Egg.

tion of the bee may be watched. At first there is but little difference in the form, but in a week the limbs are all plainly visible. The eyes and mandibles then begin to assume distinct shape and colour, and the various parts of the delicate tongue can be traced out under the membrane which encloses the whole of the body. In a fortnight the

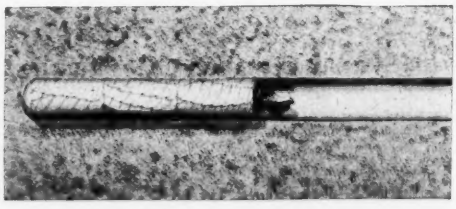


Fig. 20.—Three Cells.

joints appear and then the hairs on various parts, and in a month's time the bee appears quite ready to burst through its delicate shroud. This generally happens in early morning, and is a sight to be remembered. After brushing each organ, and pluming each wonderful hair, the bee is ready for its virgin flight. Occasionally the bees are matured some time before they emerge in June.

It is a remarkable fact that the eggs laid first in the lower cells produce females, which take some days longer

to reach maturity than do the males, which are always produced from the eggs laid last in the cells nearest to the entrance of the burrow. This egg laid last is matured first, and the bee (a male), excavating its way into the open air, leaves its cell empty, so that the bee below it can then eat its way through the cap of leaves and pass out through the empty cell (Fig 24). The third bee does the same, and

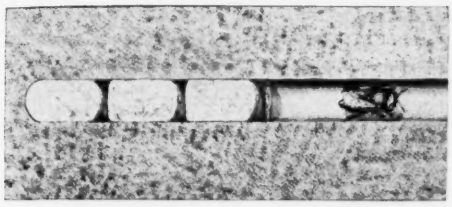


FIG. 21.—Section of Cells and Puddings.

so on until the last bee (the egg of which was laid first) is enabled to pass through the whole of the other cells until she reaches the open air.

The peculiar bee the sole representative in this country of the genus *Anthidium* is fond of taking to any old hole in a post or tree. It has the habit of collecting the woolly tomentum from the stems of the hollyhock. The bee runs up the stem and quickly divests it of its covering, which it heaps up into a ball and holds between the legs and mandibles. This material is used in the formation of its cells. I used to take this bee plentifully in my garden near Finsbury Park some twenty years ago, when houses and smoke were not quite so plentiful as now. The male is very much larger than the female, and has its abdomen terminated by an armature of strong spikes.

Two small bees constitute the genus *Chelostoma*—the larger one, *C. florisomne*, being particularly fond of the flowers of mignonette, wild and cultivated; while the smaller, *C. campanularum*, is plentiful in the delicate hare-bell.

The bees forming the genera *Heriades* and *Ceratina* are

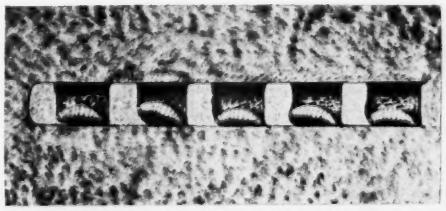


FIG. 22.—Larvæ feeding.

both strangers to me. The records of the capture of *Heriades* are somewhat doubtful. Naturalists cannot be too exact in such matters.

Eucera longicornis is the only one of the genus and is a very beautiful bee. The male has immensely long antennæ that reach right over and beyond the tail when the bee is flying. A large colony used to exist in the bank bounding the horse exercise ground near the Vale of Health at Hampstead. It has long ago disappeared—even before I commenced to work this locality. At Woking it was tolerably plentiful years ago. In company with this bee I generally found its striking parasite—*Nomada sexfasciata*.

Our next bee generally makes itself heard before being seen, for of all notes (and all bees have their special ones) this is the shrillest. They love the hottest and most brillian sunshine, and they whiz past with lightning-like rapidity from flower to flower. The opal eyes of the male render it a most beautiful insect. The bank from which I used to dig these bees at Woking is, I am pleased to note, still in existence.

We now come to two bees which are also musicians, viz., *Anthophora retusa* and *acervorum*—the so-called "mason bees" of certain localities. On February 19th of this year I noticed one of the first-named species basking in the sunshine on a wall at Haslemere, while the ground was almost an inch deep with snow. This is one of my earliest records of this merry bee. At Hampstead there still exists a small colony of *A. acervorum*, and few prettier sights can be seen in April than that of the males sitting with outstretched legs at the entrance of their burrows, The intermediate legs have very long fringes of black hairs arranged in the most exact manner. In various parts of Lincolnshire and the south coast these bees absolutely

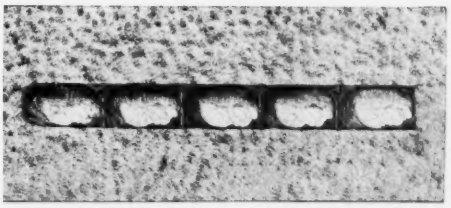


FIG. 23.—Pupæ.

swarm in the mud or mortar between the stones of walls and old buildings. The young natives catch the "white-nosed" ones, and put them into their handkerchiefs for company during school hours; but even they are wise enough not to catch the "black-nosed" ones (the females), though they are quite ignorant as to the sex, and why one possesses a sting. I once was fortunate in finding a fine specimen of the strange beetle, *Sitaris*, which is a parasite of this bee. These bees do not loiter about when on the wing, but fly with immense rapidity, coming upon one so suddenly that a nervous person is often startled by their loud hum.

Our very old friends the humble bees and their parasites (*Psithyrus*) are next in order, and so much has been written of these "bumblers" that we can only confirm the praise bestowed upon the beautiful creatures whose hum is so comforting to the tired entomologist. How eagerly do we watch for the reappearance of the hybernated females to the yellow catkins of the sallow. To these bees the farmers of New Zealand owe the fertilization of the clover.

To the bees comprising the genus *Apis* every human being is more or less indebted, for what should we do

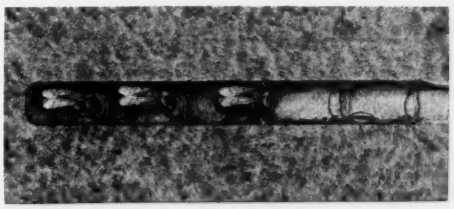


FIG. 24.—Five Cells; two vacated.

without honey or beeswax? Perhaps better than our ancient ancestors, who had not the knowledge which we now possess for manufacturing all kinds of things, pure and impure.

Bees have ever been set forth as the emblems of industry,

and the more we study the habits of the solitary species so much more does our wonder and admiration increase. When we subject each species to a microscopical examination, we find such an endless wealth of beauty of form, and marvellous adaptation of every part, that we feel utterly at a loss for words wherewith to describe their perfection.

A VALLEY ON SÃO NICOLAU, CAPE VERDE ISLANDS.

By Boyd Alexander, M.B.O.U.

On dropping anchor in Porto Preguiza, the little harbour of São Nicolau, one seeks in vain for cool verdure whereon to look and rest one's eyes. Brown, lofty hills, with acute-angled summits, chiselled by the rough hand of Vulcan, rise up with weary persistency. There are places, however, on their lower portions washed over with the filmy green of grass, a growth which is quickly eaten over by goats and the thousands of locusts that infest the plains. The little clouds now and again take pity on these pastures of stone; they come creeping to their relief, but it is often only to expire in the attempt about half way down the steep slopes. Here and there on the small plains grow scattered acacia trees (*Acacia albida*). Some are stunted as though they had devoted all their lives in trying to obtain a firm foothold in the rocky soil, while there are others with backs bent double by the strong north wind.

For the past three years rain has hardly fallen on the island, with the result that a famine is pinching the inhabitants.

The maize, the peasants' chief support, will not grow, and now they have only to rely upon the tardy arrivals of schooners filled with grain from the States.

From Preguiza a road leads up to the village of Stancha, situated in the only fertile valley that the island possesses. It is a broad, finely paved road, constructed with great skill, and with a careful eye to gradients; too good by far, and, in fact, incongruous, for such an island, where there is only donkey and foot traffic. But the Portuguese excel in road making. Furthermore, this road is the means of employing many of the native women, who would otherwise starve during frequent dearths of rain on the island.

On November 5th we travelled along this road on donkeys, and met numbers of women struggling with heavy stones upon their heads and sweating from every pore. Their work, which lasts from sunrise to dusk, is hard, and they earn scarcely enough to keep body and soul together—fourpence a day.

After a good half-hour's ride along the foot of a lofty hill range, that increased in height as we journeyed northwards, we commenced to descend a steep and capacious valley; and at the bottom of this great dried-up watercourse, just where it bends eastward to gain the sea, lay the village of Stancha, nestling amongst an abundance of tropical growth. Owing to the limited space the houses of this little town are closely packed together, the majority being nothing better than huts, with walls of rough stone pieced and stuck together with mud, and thatched with the dried blades of the maize and sugar cane. In colour the huts are a predominant brown, only a shade or two darker than the steep sides of the valley.

There are, however, besides a church, a few houses that stand out distinct, by reason of their size, white-plastered walls, and red-tiled roofs. One of these, a well-built chateau, is on an eminence overlooking Stancha, and belongs to Mr. St. Aubyn, an Englishman—and the only one on the island.

Both he and Senhor Antonio Reis, one of the principal Portuguese citizens of the place, showed us much kindness, supplying us, amongst other necessaries, with bread that was almost at famine prices.

The day after our arrival we arose early and started out to investigate the bird life of this large valley. On that particular morning an entrancing beauty seemed to hold it.

Coffee bushes clothe many portions of its sides, while on the higher ground maize surrounded the scattered huts of peasants. Here and there the coffee growth gives way to orange trees flourishing in the midst of sugar cane plantations, bordered in places near a stream's bank with strips of fish cane; while beyond, and overtopping them, are tall cocoanut trees.

All this mass of foliage forms a fine study in shades of green—the deep green of the orange leaf, and that of the cocoanut palm a few tones lighter; then the tender verdure of the sugar cane blade; and, lastly, the delicate bluish green of the fish cane.

The innumerable banana plants, with some of their large leaves in shreds, as if deftly torn by many fingers, made avenues of the streams, with banks adorned by maidenhair ferns hanging in tresses from the rocks.

Almost the first birds to draw our attention were two species of sparrows—the Santiago sparrow (*Passer jagoensis*) and the Spanish sparrow (*Passer salicicola*). We had met with them on the other islands of the archipelago, but had come to São Nicolau just at the right season to find them breeding.

Since Gould described *Passer jagoensis* as being peculiar to Santiago it has now become well distributed throughout the whole group, but it is most numerous on Santiago and Maio, where, in the latter island, its numbers are truly remarkable.

This bright-plumaged sparrow is not at all particular as to where it builds its nest. Where trees are absent, hollows underneath boulders or crevices in rocks are chosen as nesting sites. In a tree the nest is domed, but when in a hollow of the ground it is an open, compact structure, and often lined with feathers.

The eggs are four in number, and, like those of our tree sparrow, in each clutch they are fairly uniform in colour, with the exception of one, which is invariably lighter than the rest.

As to the Spanish sparrow, it breeds in the tops of the cocoanut trees, and for this reason it has received the name of the "cocoanut bird" from the natives.

While on the island of Maio we came across this species in vast numbers.

Small clumps of acacia trees in a valley close to the sea presented extraordinary spectacles. The upper branches were simply crammed with bulky domed nests, hardly a foot intervening between each, while musical chirpings issuing from a thousand throats tended to enhance the remarkable aspect of this sparrow colony.

Blackcap warblers filled the valley with their singing, while now and again a far more mellow song would come from a reed warbler (*Calamocichla brevipennis*) hidden in the depths of some coffee grove. The blackcap (*Sylvia atracapilla*) is a resident in the island, and breeds in November. We found a considerable number of nests—all built in the upper boughs of the coffee trees. The eggs of only one out of the six perfect clutches we obtained approach in any way the common type of our blackcap's; all the others are very light in ground colour, being blotched, spotted, and streaked with dark and reddish brown and underlying purplish markings—all forming a thick zone round the larger ends.

Of course we devoted much attention to *Calamocichla brevipennis*, and secured a fine series of this rare warbler, together with a couple of nests containing eggs. This species exhibits all the habits of a true reed warbler.

Though concealed from view, in yonder group of coffee bushes there is a pair. Ever and anon the male bird tempts his mate with song. First of all the male bird begins by uttering a soft, melodious "chou" several times in a deliberate and slow manner, and this call is responded to in a similar way by the female; and then the male, as if assured of her attention, pours out his string of exquisite notes. The first three notes are uttered with marked feeling and a pause follows, after which the remaining notes are given out in quick succession and in a higher key—a pretty, mellow trill being given to the last one.

This song is not unlike that of our reed warbler (*Acrocephalus streperus*), but it is of far finer quality, though not so rich in notes. English reed beds are not conducive to fine singing. A chilly atmosphere pervades them, while the reeds themselves tremble and commence to jostle one another at the mere mention of the wind's coming. And amid such disturbing influences the reed warbler utters his song, which at times becomes discordant and shrill as though he were shouting to the reeds to keep quiet.

But the other reed warbler (*C. brevipennis*) pours out his song under peaceful and lethargic influences. The leaves hardly as much as stir; a tropical heat pervades the passages of the coffee groves, and imparts to the bird just that amount of languor which makes him utter his song with soft deliberate feeling, coaxing forth the notes, as it were, till they become round and mellow—a song, truly, that haunts the memory.

The nest, figured here, is of a deep cup-shaped form,

Nest of *Calamocichla brevipennis* in a Coffee Tree.

and bound to two or more of the upper stems of a coffee bush or of a young orange tree, and about eight or nine feet from the ground.

Fine strips from the dried-up blades of the maize plant, dead grass, and the fibrous rind from the trunk of the banana tree compose the body of the nest, while fine grass and bents form the lining.

The eggs, generally three in number, are bluish white, spotted and blotched all over (but more thickly at the larger ends) with pale brown and purplish brown, with underlying blotches of violet grey.

Their dimensions correspond with those of the round form of our reed warbler.

Round about this valley a species of owl (*Strix insularis*) is met with. It is a very beautiful bird, and is closely allied to our common barn owl (*Strix flammea*). A deep fawn colour takes the place of the white in the latter, while its upper parts are suffused and marked with a rich French grey. It is by no means common, and we found it a matter of great difficulty to induce the natives to search the tops of cocoanut trees, in which these birds generally live. They look upon this owl with superstitious fear, believing that a wound from its claws never heals.

On returning home, as we entered the outskirts of Stancha, a company of Egyptian vultures arrested our attention. They gave us a lazy glance, and then stared in the opposite direction.

In spite of their repulsive habits, one cannot help possessing a sneaking regard for these birds with their wrinkled faces of the colour of yellowed parchment, for one somehow feels that they are old and venerable, and have outlived many a human life.

The birds find plenty of food about Stancha. Every morning, as regular as clockwork, they troop towards the slaughter-house and then return the same way—only a little slower this time—to an old place of *rendezvous* outside the town, where they indulge in *siestas*, now and again to awake, to ponder, perhaps, upon what the nature of the next "kill" would be in yonder house.

During the breeding season, which is generally in December, they cease to haunt the villages, and betake themselves in couples to lofty hill ranges; and then they appear again in the vicinity of dwellings with their young as February comes round.

The Cape Verde Islands are the westernmost range of this species.

Above the heads of the vultures, enjoying a pure atmosphere, resided a number of ravens (*Corvus umbrinus*) that cawed lustily from time to time.

It is very interesting to have discovered this raven, with the brown head and neck, on São Nicolau, as the species was considered by ornithologists to have its westernmost range in Egypt.

With another hour gone by the light of a brief twilight commenced to creep over the plains and then down into the valley, while the distant hills were suffused with a hue like the purple bloom on a grape. And then, as twilight glided into dusk, the stillness was broken by the locusts, who vamped incessant accompaniments to the soft music of night.

DESERTS AND THEIR INHABITANTS.

By R. Lydekker, B.A., F.R.S.

IF popular errors connected with matters scientific are hard to kill, still more is this the case when the erroneous opinions have been held by scientists themselves. The idea that flints and other stones grow is, I have good reason to believe, still far from extinct among the non-scientific; and it is not improbable that there are persons possessing a more or less intimate acquaintanceship with science who still cherish the belief that deserts are uninterrupted plains of smooth sand, originally deposited at the bottom of the sea, from which

they have been raised at a comparatively recent epoch. At any rate, there are several valuable books, published not very many years ago, in which it is stated in so many words that the Sahara represents the bed of an ancient sea, which formerly separated Northern Africa from the regions to the southward of the tropic.

As a matter of fact, these opinions with regard to the origin and nature of deserts are scarcely, if at all, less erroneous than the deeply ingrained popular superstition as to the growth of flints and pudding-stones. And a little reflection will show that the idea of the loose sands of the desert being a marine deposit must necessarily be erroneous. Apart from the difficulty of accounting for the accumulation of such vast tracts of sand on the marine hypothesis, it will be noticed, in the first place, that desert sands are not stratified in the manner characteristic of aqueous formations; and, secondly, even supposing they had been so deposited, they would almost certainly have been washed away as the land rose from beneath the sea. Then, again, we do not meet with marine shells in the desert sands, of which at least some traces ought to have been left had they been marine deposits of comparatively modern age.

Whether or no the subjacent strata have ever been beneath the ocean, it is absolutely certain that the sands of all the great deserts of the world have been formed *in situ* by the disintegration of the solid rocks on which they rest, and have been blown about and rearranged by the action of wind alone. All deserts are situated in districts where the winds blowing from the ocean's surface have to pass over mountains or extensive tracts of land, which drain them more or less completely of their load of moisture. Hence, in the desert itself, when of the typical kind, little or no rain falls, and there is consequently no flow of water to wash away the *débris* resulting from the action of the atmosphere on the rocks below.

In other words, as has been well said, desert sands correspond in all respects, so far as their mode of origin is concerned, to the dust and sand which accumulate on our high roads during a dry summer. On our highways, indeed, the summer's dust and sand are removed by the rains of autumn and winter, only to be renewed the following season; but in a desert no such removal takes place, and the amount of sand increases year by year, owing to the disintegration of the solid rock exposed here and there.

Only one degree less incorrect than the idea of their submarine origin is the notion that deserts consist of unbroken tracts of sand. It is true that such tracts in certain districts may extend on every side as far as the eye can reach, and even much farther; but, sooner or later, ridges and bands of pebbles, or of solid rock, will be met with cropping up among the sand, while frequently, as in the Lybian desert, there are mountain ranges rising to a height of several thousand feet above the level of the plain. And it is these exposed rocks which form the source whence the sand was, and still is, derived. Such mountains naturally attract what moisture may remain in the air, and in their valleys are found a more or less luxuriant vegetation. Oases, too, where the soil is more or less clayey, occur in most deserts; and it is in such spots that animal and vegetable life attains the maximum development possible in the heart of the desert.

In the most arid and typical part of the Lybian desert the sand is blown into large dunes, which are frequently flat-topped, and show horizontal bands of partly consolidated rock; and between these are open valleys, partly covered with sand, and partly strewn with blocks of rock polished and scored by the sand-blast. In such sand wastes the traveller may journey for days without seeing signs of vegetation, or hearing the call of a bird or the hum of an insect's wing. But even in many of such districts it is a mistake to suppose that vegetable and animal life is entirely absent throughout the year; in the western Sahara, for instance, showers generally moisten the ground two or three times a year, and after each of these a short-lived vegetation springs suddenly up, and if no other form of animal life is observable, at least a few passing birds may be noticed.

Among the most important and extensive deserts of the world we have first the great Sahara, with an approximate area of sixteen thousand square miles, nearly connected with which is the great desert tract extending through Arabia, Syria, Mesopotamia, and Persia. By means of the more or less desert tracts of Baluchistan, Sind, and Kuch, this area leads on to the great Rajputana desert of India. More important is the vast Gobi desert of Mongolia, and other parts of Central Asia. In Southern Africa there is the great Kalahari desert, of which more anon. In North America there is a large desert tract lying east of the Rocky Mountains, and including a great part of Sonora; while in the southern half of the New World there is the desert of Atacama, on the borders of Peru and Chili. Lastly, the whole of the interior of Australia is desert of the most arid and typical description.

But among these, there are deserts and deserts. Tracts of the typical barren sandy type are, as already said, extensively developed in the Sahara, as they are in the Gobi and the Australian deserts. Between such and the plains of the African veld there is an almost complete transition, so that it is sometimes hard to say whether a given tract rightly comes under the designation of a desert at all. A case in point is afforded by the South African Kalahari. Although there are endless rolling dunes of trackless sand, and rivers are unknown, yet in many places there is extensive forest, and after a rain large tracts could scarcely be called a desert at all. Mr. H. A. Bryden, for instance, when describing the Kalahari, writes as follows:—"And yet, during the brief weeks of rainfall, no land can assume a fairer or more tempting aspect. The long grasses shoot up green, succulent, and elbow-deep; flowers spangle the veld in every direction; the giraffe acacia forests, robed in a fresh dark green, remind one of nothing so much as an English deer park; the bushes blossom and flourish; the air is full of fragrance, and pans of water lie upon every side. Another month, and all is drought; the pans are dry again, and travel is full of difficulty." During the grassy season herds of springbok used to migrate in the old days to the Kalahari, in the northern part of which giraffes live the whole year, although they must exist without tasting water for months.

While such a district can scarcely be termed a desert in the proper sense of the word, yet its sands have precisely the same origin as those of deserts of the typical description.

For sand to accumulate to the depths in which it occurs in many parts of the Sahara and the Gobi by the slow disintegration of the solid rocks under the action of atmospheric agencies, must require an enormous amount of time, to be reckoned certainly by thousands, and, for all we know, possibly by millions of years. And we accordingly arrive at the conclusion that the larger desert tracts must not only have existed as land for an incalculable period, but also as desert. Hence we can readily understand why the animals of Algeria and the rest of Northern Africa differ for the most part from those of that portion of the continent lying to the south of the northern tropic, the Sahara having for ages acted as an impassable barrier to most if not all.

But if other evidence were requisite, there is another reason which would alone suffice to compel us to regard deserts as areas of great antiquity. The habitable parts of all deserts—and it is difficult for the inexperienced to realize what barren tracts will suffice for the maintenance of animal life—are the dwelling places of many animals whose colour has become specially modified to the needs of their environment. And it will be quite obvious that such modifications of colour, especially when they occur in animals belonging to many widely sundered groups, cannot have taken place suddenly, but must have been due to very gradual changes as the particular species adapted itself more and more completely to a desert existence.

To obtain an idea of the type of coloration characteristic of the smaller desert animals, the reader cannot do better than pay a visit to the Natural History Museum, where, in the Central Hall, he will find the lower part of a case devoted to the display of a group from the Egyptian desert, mounted, so far as possible, according to their natural surroundings. He may also turn with advantage to the coloured plate of desert finches and larks facing page 380 of the third volume of the "Royal Natural History."

Among such animals may be mentioned the beautiful little rodents respectively known as jerboas and gerbils, together with various birds, such as sand grouse, the cream-coloured courser, the desert lark, desert finches, and desert chat, and also various small snakes and lizards, among the latter being the common skink. Although some of the birds retain the black wing-quills of their allies, in all these creatures the general tone of coloration is extremely pale: browns, fawns, russets, olives, greys, with more or less of black and pink, being the predominant tones; and how admirably these harmonize with the inanimate surroundings one glance at the case in the Museum is sufficient to demonstrate. Very significant among these are the desert finches (*Erythrospiza*), which belong to the brightly coloured group of rose-finches; one of these specially modified species ranging from the Canaries through the Sahara and Egypt to the Punjab, while the second is an inhabitant of the Mongolian desert.

Among larger animals a considerable number of the gazelles are desert dwellers, these including the palest-coloured members of the group; and lions are likewise to a great extent inhabitants of deserts—as, indeed, is true of tawny and pale-coloured animals in general.

All the animals above mentioned belong, however, to widely spread groups, which are common to the desert tracts of both Africa and Asia, and they do not, therefore, serve to prove the antiquity of any particular desert, as they or their ancestors might have migrated, and probably did migrate, from one desert to another. Birds of such groups are, of course, even more untrustworthy than mammals, owing to their power of flight. And among those referred to, some, such as the sand grouse, can scarcely claim to be regarded as exclusively desert birds, since they are partial to any open sandy plains, like those of the Punjab, or even Norfolk.

The case is, however, very different with certain of the larger mammals, a notable instance being afforded by the antelopes allied to the South African gemsbok (*Oryx*). All the members of this group are inhabitants of more or less sandy open districts, and none range eastwards of Arabia, or possibly Bushire. The gemsbok itself, together with the beisa of Eastern and North-Eastern Africa, are inhabitants of districts which do not, for the most part, come under the designation of typical deserts. And we accordingly find that they are by no means very pale coloured animals, while both are remarkable for the bold bands of sable ornamenting their faces and limbs. On the borders of the Sahara there occurs, however, a very different member of the group—the white oryx (*O. leucoryx*)—differing from all the others by its curving horns, and likewise by the extreme pallor of its coloration, which is mostly dirty white, with pale chestnut on the neck and under-parts. Obviously, this species has been specially modified as regards coloration for the exigencies of a purely desert existence, and as it is also structurally very different from all its existing kindred, it must clearly be looked upon as a very ancient type, which commenced its adaptation to the surroundings of the Sahara ages and ages ago. The Arabian desert is the home of another species of oryx (*O. beatrix*), which, although more nearly allied to the East African beisa, is a much smaller and a much paler coloured creature. In this case also there would seem little doubt that the period when this animal first took to a purely desert existence must have been extremely remote.

But an even more striking instance is afforded by another antelope remotely connected with the gemsbok, which is an inhabitant of the Sahara and the Arabian desert, and is commonly known as the addax. It is an isolated creature, with no near relation in the wide world, easily to be recognized by its dirty white colour, shaggy mane, and long twisted horns. It must have branched off at a very remote epoch from the gemsbok stock, and affords almost conclusive evidence of the antiquity of the deserts it inhabits, since we have no evidence of the occurrence of allied extinct species in other countries.

Some degree of caution is, however, necessary in drawing conclusions that all isolated desert animals have been evolved in the precise districts they now inhabit. A case in point is afforded by the saiga, a pale-coloured antelope without any very near kindred, inhabiting the steppes of Eastern Russia and certain parts of Siberia, where it is accompanied by the hopping Kirghiz jerboa (*Alactaga*). Now, since fossilized remains of both these very peculiar animals have been discovered in the superficial deposits of the south-eastern counties of England, it is a fair inference that physical conditions similar to those of the steppes (which, by the way, are by no means true deserts) obtained in that part of our own country at an earlier epoch of its history. From their comparatively isolated position in the zoological system, as well as from their occurrence in the strata referred to, both these desert animals evidently indicate very ancient types; and they accordingly serve to show not only that the semi-desert steppe area formerly had a much greater western extension than at present, but probably also that the existing portion of that area dates from a very remote epoch. Hence they confirm the idea of the early origin of the present deserts of the Old World and their inhabitants.

It will be gathered from the foregoing that the deserts and steppes of Africa and Asia possess a large number of animals belonging either to species which have no very near living relatives, or to altogether peculiar genera. In the Arizona desert of the Sonoran area of North America it seems, however, to be the case that its fauna is largely composed of animals much more nearly related to those inhabiting the prairie or forest lands of the adjacent districts, of which, in many cases at any rate, they constitute mere local races distinguished by their paler and more sandy type of coloration. This is well exemplified by the mule deer, which in the Rocky Mountains is a comparatively dark and richly coloured animal, but becomes markedly paler on the confines of the Arizona desert, assuming again a more rich coloration when it reaches the humid extremity of the Californian peninsula. Most of the North American mammals, indeed, acquire similar

pale tints as they reach the Arizona desert tract; and a practised naturalist can pick out with comparative ease the specimens coming from this area from those of the moister districts.

It is not easy to obtain information as to the physical features of the Arizona desert as compared with the Sahara, and especially as to the amount of sand it contains area for area; but, judging from the comparatively slight modifications which its mammals appear to have undergone as compared with those of the more humid regions adjacent, it seems not unlikely that these deserts are of more modern origin than the Sahara and the Gobi.

Whether or no it be true in this particular case, it may be laid down as a general rule that the greater the amount of sand to be found in a desert, and the greater the difference between the animals inhabiting that desert from those dwelling in the adjacent districts, the greater will be the antiquity of the desert itself. In the case of a desert forming a complete barrier across a continent, like the Sahara, if the animals on one side are quite different from those on the other, its antiquity will be conclusively demonstrated. If, on the other hand, they are more alike, the age of the desert will be proportionately less.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—III.

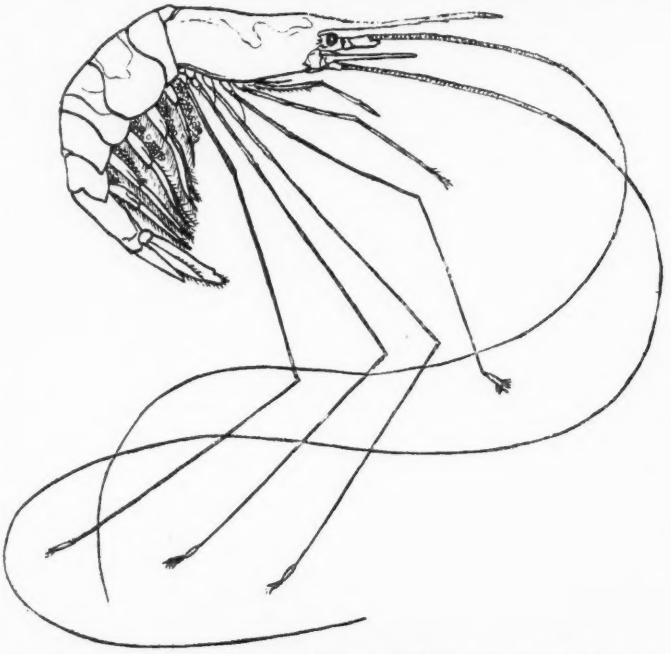
By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

THE poet says, "Tell me where is fancy bred." The philosopher asks, "Where shall wisdom be found?" To the carcinologist it is no less important to inquire where he should search for Crustacea. To him a comprehensive answer may be given that, with one exception, there is no sort of place on the garment of the globe where they may not be encountered. Like adventures to the adventurous, they will meet the expectant observer as well in his daily rambles as in his most audacious wanderings from Pole to Pole.

Only in arid deserts the pursuit is at a monstrous disadvantage. For almost every crustacean specimen might claim a share in the sweet singer's epitaph: "Here lies one whose name is writ in water." Whether Mammalia have had marine ancestry may be disputed by the disputatious, but few will care to deny that crabfishes and the whole crustacean tribe must have begun the business of life in the sea. Out of water, and out of salt water, the most part cannot sustain life at all. Almost all of them are dependent for health and activity on an abundant and constant supply of moisture. The comparatively small number of terrestrial species, by their close affinity to the aquatic hordes, show that they themselves must have had water-breathing progenitors. Some of them, as is well known, make periodical pilgrimages to lay their eggs in the ancestral sea. In lakes which are evidently upraised and isolated fragments of the ocean, crustaceans are found the counterparts of others which are still marine.

From the general facts of the distribution one may believe that the Crustacea began in moderately shallow water, and that they have thence spread themselves on the one hand to the shores, up the rivers, over plains, valleys, and mountains, and on the other hand into all depths and all quarters of the widespread sea. Thus, to deal with them efficiently as a whole you need a dredge and a trawl, a boat and a ship. You need a navy. That such an expression is not hyperbolical can easily be proved. For though the names of the *Racehorse*, the *Discovery*, the *Vincennes*, the *Samarang*, the *Astrolabe*, and others may be little remembered in connection with the progress of carcinology, yet the *Lightning*, the *Porcupine*, and the *Challenger*, the *Talisman* and the *Travailleur*, the *Blake* and the *Albatross*, have been made familiar to the present generation by popular narratives as well as by volumes of profound research. Without entering into rivalry with Homer in his famous "Catalogue of the Ships," which is after all only a sum in addition, one may make honourable mention of the *Novara*, the *Joséphine*, the *Vettor Pisani*, the *Dijmphna*, the *Willem Barents*, the *Alert*, the *Hauch*, the *Buccaneer*, the *Hirondelle*, the *Princesse Alice*, the *Hassler*, the *Caudan*, the *Investigator*, and still leave the list uncompleted. Some of the vessels, no doubt, have been less important for their size than for their services. A full enumeration of them, nevertheless, would show a notable international fleet. The immediate object of each expedition may have been geographical discovery, the sounding of depths, the laying of cables, astronomical observations, magnetic surveys, or other such trivialities; but overruling destiny employed them all—more or less—in catching crustaceans.

The ocean floor is difficult of access. The ocean surface is more easily skimmed from a boat than from a man-of-war. But, whether from boat or pier or ledge of rock, the sweeping of that surface with a hand-net is productive of treasure. It is rich in larval forms of various groups. It is thronged with innumerable Entomostraca. For some captures the night is the most favourable period. At some times and places the abundance of individuals is overwhelming. Square miles of ocean may be coloured by the blood-red *Calani* known as "whale-food." To a cetacean, with one or two thousand pounds worth of plates of whalebone depending from its cavernous skull, the extravagant

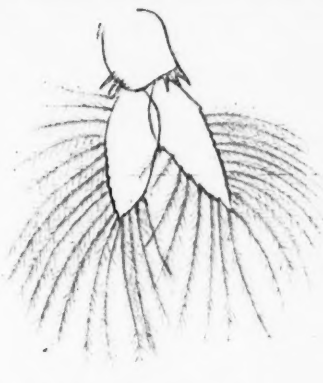


Nematocarcinus Agassizii (Faxon). Deep-sea Shrimp, taken by the *Albatross*. Life size. Upper antenna imperfect.

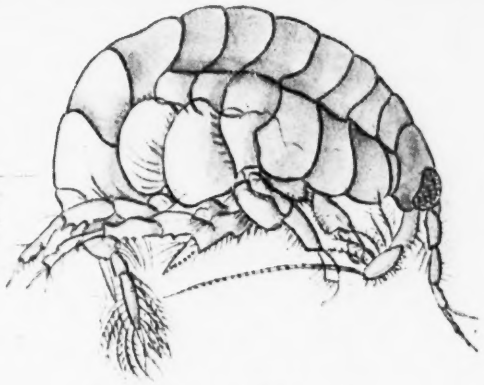
quantity of these Copepoda is not unwelcome. To the naturalist the superfluity of this or any other single species is distracting. He does not wish the novel or the rare to be concealed or entangled amidst the multitudinous. At times, however, numbers help to enhance the charm as well as the wonder of the scene presented. Especially is this the case with the genus of Copepoda called *Sapphirina*, concerning which Dana says that nothing can exceed the beauty of some of the species, conspicuous in single specimens, but still more when they are congregated in abundance. "On account of their extreme brilliancy and rich reflected tints they may be seen at great depths on a sunny day, and as each becomes visible only when the position is right for the observer's eye, the water seems to flash with moving gems; they even rival the richest opal and sapphire, and the most brilliant combination of metallic hues." So they endear themselves to the observer, and he distinguishes the fascinating species as "the belle," "the rainbow," "the gem," "the radiant," "the resplendent."

There was a time when collectors deplored that on board a swift ocean steamer they could not ply their favourite occupation. That tantalizing era is at an end. As explained in recent papers by Giesbrecht* and Herdman,† small invertebrates from a few feet below the surface can now be easily obtained while the ship is in full career, by day or by night, in tempest or in calm. The water which is continually being drawn into the vessel to supply tanks and baths is simply filtered through nets, which detain the desired organisms. Dr. John Murray, Captain Hendorff, and Dr. Krämer are credited with having been the pioneers in this method of retrieving—so facile, so fruitful, so inexpensive. Thus far it appears that a large proportion of the game which is bagged in this ingenious manner consists of Copepoda. How great a hold these and other Entomostraca have obtained on all the waters of the globe, both fresh and saline, will be considered hereafter in connection with notes on their classification. For the Copepoda in particular Mr. I. C. Thompson has recently called attention to the grand economic service rendered by their immense profusion at the mouths of rivers and outside harbours. Transmuting the importunate refuse of populous towns into their own minute forms of life, they in turn become the food of larger marine animals, variously adapted to gratify the palate of Lucullus, to illumine his banquet, or adorn his person.

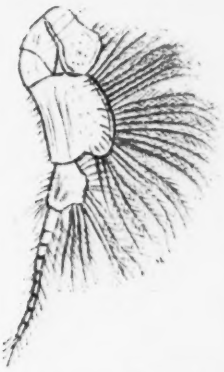
The sea-shore is generally rich in crustaceans. It is almost always far richer than might be supposed from a casual survey. The common shore crab, by way of exception, is an impudent, defiant creature; but even the fighting shore crab is coloured for concealment, lies low by preference, and, upon occasion offered, adopts the policy of scuttle. As a rule the crustaceans of the shore don't want to fight—at least not with human antagonists. They do not court the eye; they make themselves small. They burrow; they hide under stones, in crevices of rock, in folds of seaweed, in neat but unobtrusive tubes, built by themselves or borrowed. They mimic surrounding objects. They prowl about in the shells of untempting molluscs. In captivity some of them change colour; some of them flounder about as if indignant. The prawns and shrimps and hoppers make astounding and unexpected leaps and bounds—not into the arms of the intellectual observer, but in the other direction, in an unappreciative sort of way. There are Tanaids and Cumacea so tiny that to look for them in the sand which they inhabit is like looking for a needle in a pottle of hay. These can be obtained by stirring about a spadeful of the shore in a bucket of water, and then pouring the water through a fine net before the small animals have had time to bury themselves once more in the subsiding sand. The amphipod, *Haustorius arenarius*, can be obtained in the same manner, but also by simple digging, as it is a monster half an inch long. It will "scriggle" in the hand, but is warranted harmless. Often, however, when taken, it morosely or modestly folds itself up, unwilling to display the beauties which, were it an exotic species, would make it a prize. It appears to be little known, though widely distributed on the sandy shores of our islands; and much the same may be said of the species of *Urothoe* and *Bathyporeia*.



Last uropod of the *Urothoe*, highly magnified.



Urothoe brevicornis (Bate). From North Wales.



Second antenna of *Haustorius arenarius* (Slabber).

It should be remembered that the population of the sand is in general quite different from that of the seaweed-covered rocks and stones, and this is illustrated in a rather remarkable manner by the distinction between the sand-hoppers and the shore-hoppers, although the two groups are closely related. Of the rock pools it must suffice to say that, in sheltered and unfrequented spots, they are often Liliputian gardens of marine zoology, from which many interesting crustaceans may be gathered, either by examining tufts of weed or by fishing with a fine net. Different forms are to be expected, according as the climate of the district explored is cold, temperate, or tropical; but some species have an extremely extended and others a very

* *Abdruck aus den Zoologischen Jahrbüchern*, Neunter Band, 1896.

† From *Trans. Liverpool Biol. Soc.*, Vol. XII., 1897.

limited distribution. The mangrove swamps of the tropics are distinguished by a highly remarkable crustacean fauna. The weed of the Sargasso Sea may be regarded as a kind of floating shore. It has its own crabs and shrimps. Turtles and hairy crabs play the part of floating islands to a considerable population, and an anchored buoy is often rich in amphipods among its fringing weeds.

To the general policy of concealment above described there are some exceptions. On the open shore the sessile cirripedes called Balani make no pretence of hiding. Being cemented to the rock, they cannot run away if they would, and they have little reason to wish for the power. The hermit crab may say, like an Englishman, "My house is my castle"; but the Balanus is a castle in itself. Six rigid interlocking valves make a stout wall round about it, and the movable valves above, through which from time to time the delicate cirri protrude, can be firmly closed down at the top. Great stretches of coast-margining rocks are coated with colonies of these Balani. But there are many other situations in which cirripedes occur. Like the spider, which impartially fastens its web to the rafter of a cottage or the ceiling of an imperial palace, the cirripede plants itself on the body of a whale or the carapace of a crab, on the iron sides of a merchantman or on a piece of pumice. It will cluster in dense masses round an old floating bottle, and some of the small species crowd the mouth-organs of crab or crawfish, with easy security, where they might seem to be running into the jaws of death. The sausage-like *Pachybdella carcini* is parasitic on the tail part of *Carcinus mænas*, the above-mentioned shore crab, and within reach of the claws of its host. Now, if there is one thing more than another about which the shore crab is touchy, it is about having its tail part drawn away from its breast, except by the intervening mass of its own numerous eggs. No doubt the heartless *Pachybdella*, brainless impostor though it be, is all the while making believe to be the eggs of the deluded shore crab. But the afflicting behaviour of parasites is too extensive a subject for the end of a chapter.

Platyarthrus Hoffmannseggii (Brandt). From ants' nest, South of England.

Of inland Crustacea there is much to be told, of which only a hint or two can here be given. Several of the groups are but poorly represented in our own islands. Apart from Entomostraca, our fresh waters can boast of a crayfish and here and there a prawn, of the isopod *Asellus communis*, and of a few Amphipoda in rivulets, lakes, and wells. We have nineteen species of terrestrial Isopoda, these woodlice including the small *Platyarthrus Hoffmannseggii*, found only in ants' nests—blind, slow moving, white; and the delicate *Trichoniscus roseus*—nimble, rose-coloured, and rare. Exotic species of sessile-eyed crustaceans may chance to be found in our botanic gardens as they have been in France. But no land crabs are likely to disturb our picnics, requiring as in Panama the flourish of a cudgel to repress their effrontery. No river crabs ascend the summit of Helvellyn to match those found at similar heights in Himalayan ricefields. No little mole of a crayfish burrows under our flower beds, as in Tasmania. We have no prawns like those of America, which rival the size of large lobsters; or like those of the Ganges, concerning which the Asiatic complacently observed to the fastidious Englishman, "Prawn eat nigger—nigger eat prawn." No hermit crabs on our hills confront the geologist as they do in the West Indies, marching about among the bush in large and heavy shells transported from the beach a thousand feet below. No *Birgus latro*, strange hermit without a shell, is here seen competing for cocoanuts as in the islands of the Pacific. But notwithstanding some deficiencies, our position is extraordinarily favourable for the study of Crustacea. The extensive seaboard with its many sheltered bays and inlets and harbours; the variety of climate from north to south and from summer to winter; the differing depths of water round our coasts; the ebb and flow of tides; the mud, the sand, the weeds, the rocks, the stones of the shores; the frequent occurrence of wooden piles for piers or breakwaters, of buoys and other floating objects; the abundance of fish and of empty shells, severally enable us to accommodate a multitude of crustacean species out of proportion to the space our islands cover on a map of the world. To become familiar with the names and with the nature, with the habitat and with the habits, of all these species, will be found a task the more inexhaustible the more absorbing the industry brought to bear upon it.

NEBULÆ AND REGION ROUND γ CASSIOPEIÆ.

By Isaac Roberts, D.Sc., F.R.S.

THE photograph covers the region between R.A. 0h. 45m. and R.A. 0h. 55m. 57s.; declination between 59° 21′ and 61° 2′ north. Scale—one millimètre to twenty-four seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch A.D. 1900.

Star (.)	D.M.	No. 124	Zone	+60°	R.A.	0h. 47m.	7·5s.	Dec. N.	60° 33·9′	Mag. 5·0
,, (..)	,,	146	,,	59°	,,	0h. 50m. 45·6s.		,,	59° 49·3′	,, 6·3
,, (:·)	,,	137	,,	60°	,,	0h. 51m. 16·1s.		,,	60° 53·1′	,, 7·0
,, (::)	,,	161	,,	59°	,,	0h. 53m. 57·5s.		,,	59° 58·3′	,, 7·2

The photograph was taken with the twenty-inch reflector on 1895, October 25th, between sidereal time 0h. 16m. and 1h. 46m., with an exposure of the plate during ninety minutes.

On the *north following* side of γ are two nebulæ having the outlines of cones or fans, with faint nebulosity between them, which on the negative can be traced nearly the whole distance between one nebula and the other; the apexes of the nebulæ are bright, and the brightness diminishes gradually into invisibility as it expands outwards from the conical ends. The nebula farthest from the north is brighter than the other, and both have a cloud-like structure, with many stars of between the ninth and seventeenth magnitudes involved, apparently, in them.

The following are the measured position angles and distances of the nebulæ.

Position angle from γ of the faint star touching the apex of the conical end of the northernmost nebula, 14° 26′ 12″; distance from γ 22′ 46″. Position angle of the faint star touching the apex of the other nebula, 57° 34′ 51″; distance from γ 19′ 19″.

A photograph of the region here referred to was taken on 1890, January 17th, upon which the two nebulæ were faintly, but distinctly, shown; and I have compared the

NEBULÆ NEAR γ CASSIOPEIÆ.

By ISAAC ROBERTS, D.Sc., F.R.S.

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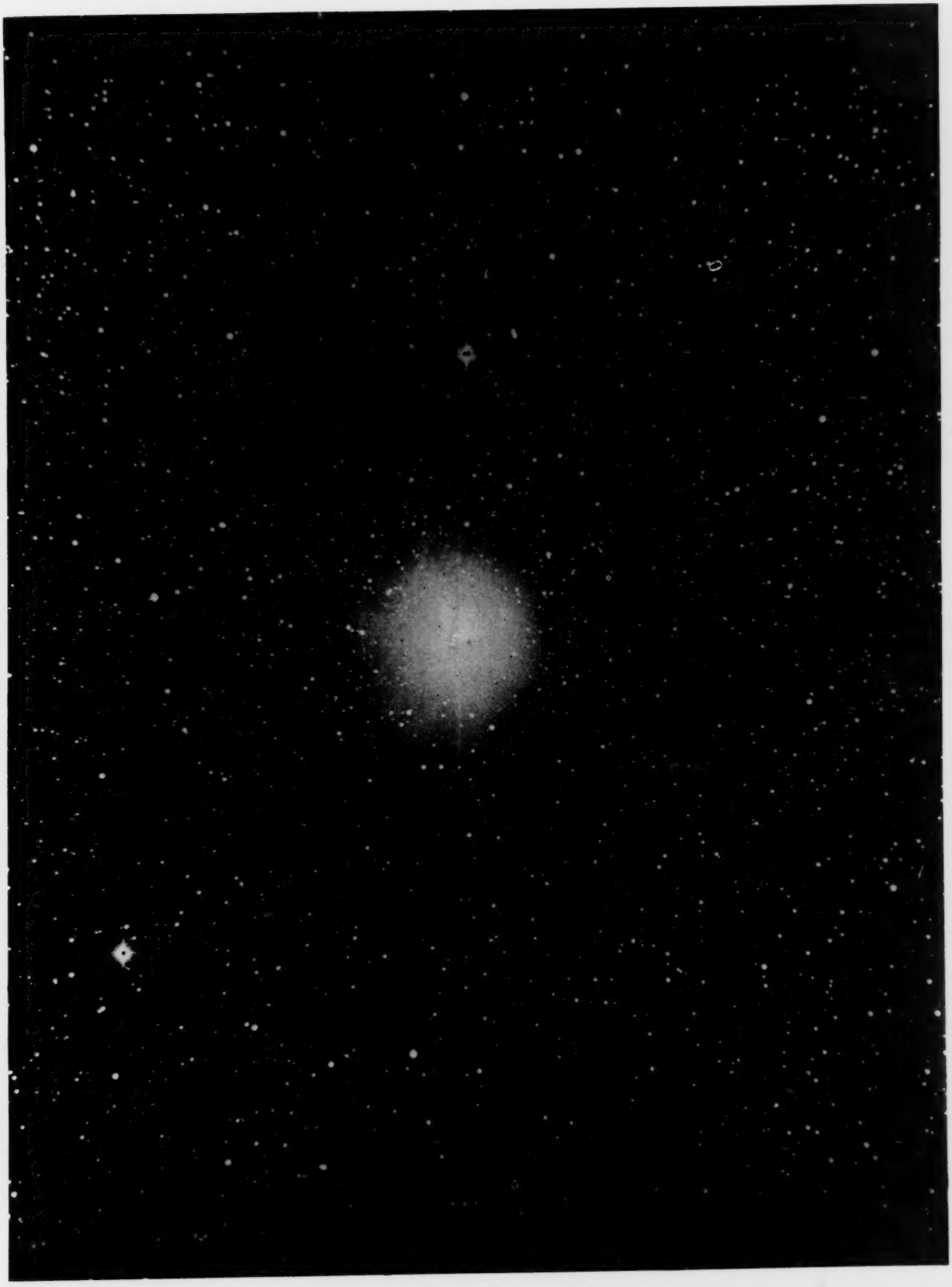

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original negative of that photograph with the one here depicted, with the result that no obvious change could be detected to have taken place, either in the nebulæ themselves, or in the relative position angles, or distances between them and γ, or of the surrounding stars.

An interval of five and three-quarter years is therefore too short to show sensible changes to have taken place in these objects. From this it follows that their distances from the earth are great; and we have yet no unquestionable evidence to prove that the nebulæ are physically connected with the star γ, but their apparent distances from the star are not too great for us to entertain the possibility of such a physical connection.

The diffused patch of light surrounding γ must not be mistaken for nebulosity; for it is caused by the strong light of the star illuminating a part of the earth's atmosphere affecting the photographic plate during the exposure. This atmospheric glare is of the same character as that observed in forming halos round the sun, moon, and bright stars; but the possibility of the star having an extended coronal light around it should not be omitted from consideration, for, though it might exist, its structure would be masked on the photograph, by the atmospheric glare, as effectually as that of the solar corona is masked.

There are many stars visible on the negative involved in the patch of glare, but they cannot be reproduced on the photo copies, for the reason that if the glare is printed out so also are all the stars that differ but little from it in density.

A dense photo image of the star can be obtained with the twenty-inch reflector in a small fraction of a second of time; but an exposure during an hour, or more, is required to show the fainter parts of the nebulæ, and the faint stars, with clearness.

THE RECENT ECLIPSE.

By E. WALTER MAUNDER, F.R.A.S.

THE methods of investigation employed during the late eclipse were so numerous, and their general success so great, that it seems impossible to give any adequate account of the entire campaign in a single paper. I have therefore thought it would be better if I confined myself to the work on which my wife and I were immediately engaged, and I have no doubt that the editors will easily be able to arrange for a succession of similar papers, contributed by observers engaged in other departments.

My wife and I, when we contemplated going to India to take part in the eclipse observations, found ourselves confronted by an extremely difficult problem. Our instrumental means were of the very smallest. They consisted of a small binocular, one eyepiece of which was fitted with a little direct-vision prism, and of a photographic camera, the lens of which, though of high quality, had but an aperture of one and a half inches, and a focal length of nine inches. We could not but compare, with something like a feeling of dismay, this almost microscopic equipment with the magnificent instruments with which the members of the official parties were furnished, or which the directors of large observatories had at their disposal. We were standing up in line, armed with our little flint-headed arrows, whilst our comrades in the battle were rejoicing in the possession of Maxims and Lee-Metfords.

Still, after looking the problem round, we concluded that it was not one to lose heart over. We saw our way to at least trying three lines of work. With the opera-glass and prism I intended to ascertain the distribution of coronium in the corona, and especially to see if it showed the rifts and rays which form so striking a feature of coronal structure as it appears to the eye. With the camera, we thought that we might try, first, by giving a very long exposure to obtain an image of the long coronal streamers, and secondly to photograph the corona, if possible, after the end of totality.

All three enterprises appeared very hazardous. It was exceedingly doubtful under the first head whether, with so small a dispersion, the 1474 K light would be sufficiently strong to declare itself over the continuous spectrum which the corona also gives. The attempt to secure the long extensions was less likely still. Only a week or two before we left England Miss Clerke, whose admirable judgment and exact insight in astronomical matters have deservedly won such wide and general confidence, had written:—". . . the camera, owing to special difficulties, has not yet been able to pursue them [the coronal extensions] so far as four solar diameters." ("Concise Knowledge Library," Astronomy, p. 268.) And Mr. Albert Taylor, in a paper read before the Royal Dublin Society in 1894—a paper evidently most carefully thought out and in the conclusions of which our own experience led us to place great confidence—had laid down that the maximum effective exposure for F/15 in coronal photography was thirty seconds—that is to say, for our camera five seconds. Such exposures had on former eclipses failed to give any great extensions; indeed, had generally proved less effective than shorter exposures, from the cause Mr. Taylor so clearly points out—the great brilliance of the sky background. Whilst the last item on our programme seemed, *à fortiori*, to be more doubtful still.

It will be seen that our prospects did not appear too brilliant. Nevertheless, we felt strongly that if new fields of eclipse work were to be opened up it necessarily involved the risk of failure in the first experiments, and those first experiments might be made as effectively on a very restricted scale as on a large one. Their success would be no less indubitable, their failure far cheaper.

And we felt that we were justified in undertaking this risk. We received absolutely no financial help from Government or any other public body,* either for our equipment or for our personal expenses in our expedition, and we were therefore hampered by no restrictions whatsoever.

We had, moreover, grounds for hope. We had made a few experiments in the use of the "Sandell" double and triple coated plates, and had been convinced that they at least offered us a chance over and above that which ordinary dry plates afforded. It seemed to us that, by their use in conjunction with a slow and prolonged development, it might be possible to bring up the faint extensions of the corona before the sky glare blotted them out; whilst in view of Prof. Wadsworth's recent papers, the very smallness of the scale of our instrument formed an encouragement.

One difficulty, however, remained. The second item in our programme demanded an equatorial and driving clock. These we were without, but the Council of the Royal Astronomical Society very generously placed at our disposal the pretty little equatorial and camera bequeathed to it by the late Mr. Sidney Waters, F.R.A.S., and met the expense of putting it into full working order.

The camera attached to this equatorial was not suitable

* The generosity of two members of the British Astronomical Association enabled the Eclipse Committee of that body to undertake the expense of insuring the instruments taken out by the members of its two expeditions, and we have to thank them for our share in this benefit.

for the special work which we had in contemplation, but it seemed to us that we might make good use of it. It was fitted with one of Dallmeyer's telephotographic lenses, and had a full aperture of nearly two and a half inches and an equivalent focal length of almost eight feet. The magnifying power employed was therefore very nearly twelve diameters. This appeared to us much too high, but the definition which we actually obtained justified Mr. Waters in his choice of so great a scale, and forms the highest possible testimonial to the quality of Mr. Dallmeyer's optical work. Our idea was that with the two cameras we might obtain a series of photographs, the equivalent exposures of which might be arranged so as to form a geometrical series ranging from the shortest up to Taylor's limit. The common ratio in this case was about four and a half, and, taking Taylor's limit as unity, ranged from one four-hundredth up to one. We thought this additional item would not be devoid of interest, as it seemed to us that not a few coronal photographs on former occasions had failed to be so successful as they might have been through over exposure.

So much as to our programme; now as to our results.

With the prismatic opera-glass, my first sensation, after watching the indescribably beautiful changes which the spectrum underwent as totality came on, was one of profound disappointment. The continuous spectrum entirely swamped nearly all the bright rings except those of hydrogen and helium; and the 1474 K ring, either because it was fainter on the eastern side than on the western, or because my eyes took some time to become attuned to the light, was not seen till after the middle of totality. It was then detected over an arc of about one hundred and forty degrees—that is to say, only in the semicircle round the point of third contact, and not over the whole of that, as the continuous spectrum was necessarily so bright at its two edges as to swamp the bright line spectrum there. Still, over this one hundred and forty degrees the "coronium" ring was perfectly continuous, it was interrupted by no rifts, it spread out into no rays. It was traceable to a height of between five and six minutes from the moon's limb, and corresponded therefore very closely to what to the eye appeared to be the brightest inner corona. So far, then, "coronium" appears to be pretty evenly distributed round the sun, and not to follow the striking and characteristic forms which attract such notice in the corona as seen directly.

Our second field of work, the attempt to photograph the long coronal streamers, met with a most wonderful success. Our two long-exposure plates—four times Taylor's limit—equivalent to one hundred and twenty seconds with F/15—

showed the four principal coronal streamers to a much greater distance than ever before. They can be clearly and unmistakably followed to distances from the moon's centre of three, four, four and a half, and six diameters respectively. In the case of the great south-west ray we believe that we have traced it, though very feebly, under suitable illumination, to a much greater distance still, and we may have further remarks to make upon its details on some future occasion. As it is, however, it is beyond challenge that this south-west ray is shown clearly and distinctly upon two photographs much further than has been the case in any photograph of the corona that has ever been taken before.

Indeed on three photographs. For beside these two long-exposure photographs taken on "Sandell" plates (kindly developed by Mr. J. T. Sandell himself), a third photograph taken with one quarter the exposure—practically Taylor's limit—an "Ilford extra rapid" plate which we developed ourselves, might have claimed, had it not been for the two "Sandell" plates, to have given the record coronal extension.

The orientation of these three plates is given with great

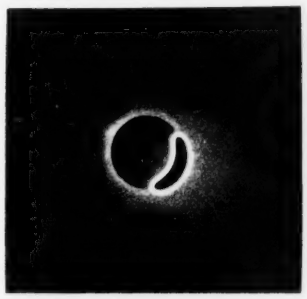
precision by the presence upon them of Venus, which burned like a lamp some six degrees away from the sun. The plates were amply large enough to take in the planet, since they were sixteen centimètres square; and the focal length of the lens being nine inches, six and one-third degrees correspond to an inch, and the solar diameter is almost exactly one-twelfth of an inch.

We learn at once by this means that the great south-west ray, so far from coinciding with the sun's equator, lay in thirty-five degrees south latitude. The two rays which composed the "fishtail" on the eastern side of the sun, lay some twenty-four degrees north and south of the equator respectively, the equator itself therefore being void of any great streamer.

It will be seen that, in disregarding Taylor's limit, we have been abundantly vindicated by the result. Nevertheless, the considerations Mr. Taylor urged in the paper alluded to substantially held good. In developing these plates, even the one with only five seconds exposure, the general sky glare came up deep and black at an early stage. Here we owe our success to the fact that we exposed two plates for each given exposure. The companion plate to the Ilford five seconds was in itself a comparative failure, but its development gave us the experience and courage necessary to push the development of its more fortunate comrade to a successful conclusion.

Our last photograph was the most important. Totality was over by nearly two minutes when we exposed a plate with our little camera for a second and a half. This on development yielded us not only the brilliant arc of sunlight, but showed an unmistakable coronal ring, for the entire dark disc of the moon is seen upon it.

This success, we may well hope, will have far-reaching effects. It is a very long way from realizing that ambition of so many astronomers, the photographing the corona in *full* sunlight. But the corona has never before been photographed unmistakably and beyond challenge in *so much* sunlight. And even should it never lead on to the desired goal, something has at least been done to lift large partial eclipses from the category of being astronomical mere waste material. It will be a distinct advance if in future we can fix the positions of the roots of the great coronal rays on such more frequent occasions: a most necessary advance if we are to learn the true nature of coronal change and motion.



Our experiments, therefore, were successful beyond our hopes, and their success seems to justify us in having made them. Yet had they failed we feel that we should have been not one whit less justified.

But our photographs are on an almost microscopic scale, and although sufficient to prove the practicability of our methods it is much to be desired that they should be repeated on the next occasion with ampler means. We feel it incumbent on us, if any way possible, to take part in the observation of the next eclipse, that of May 28th, 1900. We want to photograph the sun during the entire period of the partial phases, to give a considerable range of exposures, and to try the effect of various developments. We want, in short, to follow the corona to the utmost extent which the sunlight permits. We want also to obtain the greatest possible extension of it. We want also to give two exposures during totality of much greater length than the longest we gave in India. These experiments we are prepared to carry out with the little camera which has just done us such yeoman service, but we earnestly hope that we may also be entrusted with instruments that may enable us to duplicate this programme, but on a much larger scale.

The accompanying pictures are reproduced from drawings which Mr. W. H. Wesley has most kindly made from the original long-exposed photographs. Amongst other details of interest Mr. Wesley especially remarks on the corroboration which these negatives afford of certain well-known drawings of the corona. Hitherto there has been a wide difference between the corona as presented us on the sensitive plate and in drawings even of the most trustworthy observers, and this fact has thrown a good deal of doubt upon the value of such drawings. A comparison of the corona as here shown with the well-known drawing, by Captain Bullock, of the eclipse of 1868, shows a most remarkable resemblance between the two. If the two were representations of the same eclipse one could not ask a more complete correspondence.

Notices of Books.

A New Astronomy for Beginners. By David P. Todd, M.A., PH.D. (The American Book Company, New York. 1898.) This book deserves an appreciative welcome. It is moderate in compass, precise in plan, succinct in treatment. There is a freshness about it, too, that pleasantly reminds one of its origin in a "new" continent. *Loci communes* are few; the topics introduced are mostly discussed from an original point of view; students are made to feel the *inwardness* of them. A "pedagogic purpose" is throughout kept in view. The fundamental idea of the volume is to teach astronomy as a science of observation—to inculcate principles and indicate modes of working them out in practice, no matter how roughly, were the available equipment "but a yard stick, a pinhole, and the rule of three." One recalls—be it said without prejudice—the system in vogue at Dotheboys Hall of learning botany by planting cabbages. For, apart from the rigorous *sic ros non vobis* code there enforced, that system possesses high excellences and manifold resources, which Prof. Todd's sixteen years' experience as a teacher enables him to develop to the full. With resourceful ingenuity, he makes the "appeal to observation which can alone," as Huxley wrote, "give scientific conceptions firmness and reality." In the pages before us, precepts are given for pursuing a "laboratory course" in the study of the heavenly bodies; the construction of home-made apparatus, needing only "moderate mechanical deftness," is described preferably to the latest refinements of modern instrumental methods; nor can we doubt that its use, while flattering the instinctive egotism of beginners, tends at the same time to develop in them both mental alacrity and manual aptitude. The present author, while rightly dwelling upon "the importance of thinking rather than memorizing," lets them off with perhaps undue ease from the stern necessity of confronting mathematical difficulties. Yet we cannot find it in our hearts to quarrel with the capital illustration at page 398, where an instantaneous photograph of a "foul ball" at cricket replaces a formal demonstration that "a projectile's path is a parabola." The book is to a most praiseworthy extent "up to date." The newest results in every department are included in it—included, perhaps, with too slight an allowance of grains

of salt, desirable *caveats* being here and there conspicuously absent. We note, however, with satisfaction that the author has boldly adopted Schiaparelli's long periods of rotation for Mercury and Venus, while withholding an unqualified assent from the hypothesis of "irrigation works" on Mars. A few slips and errors might be pointed out, but they are in general not very material. The most misleading is an attempt to explain stellar variability by the *direct* analogy of sunspots, the actually subsisting relation being of the inverse kind. Most of the illustrations are new and excellent. Only the coloured frontispiece savours of claptrap.

A History of Fowling. By Rev. H. A. Macpherson, M.A., M.B.O.U. (Edinburgh: David Douglas.) Illustrated. We have in this volume a detailed and exhaustive account of the many curious devices by which wild birds are or have been captured in different parts of the world. The energy, the pains, and the time which the author has expended in the compilation of his work may be gathered from the fact that his plan has been, as he tells us in the introduction, "to read through every ornithological work that I could find, in the five or six languages which are all that I can personally translate"; besides which he has elicited much information by correspondence with persons in Japan, China, Borneo, India, Australia, New Zealand, as well as in many different parts of Europe, Africa, and America.

The result is that we have a book which will long remain as a classic upon the subject of past and present fowling (exclusive of the use of gunpowder) in every part of the world. Comment upon such a book is needless, since it is evident at the outset that the author has made himself a thorough master of his subject. The book is profusely illustrated; many of the cuts being taken from rare and quaint prints and drawings specially prepared from specimens of traps and devices which the author has procured from many parts of the world. The book is printed and bound in the sumptuous style generally adopted by Mr. David Douglas—a style very well suited for a book of this character, but the use of which cannot be too strongly condemned for books which should be within reach of the purse of every naturalist.

It is neither our intention nor indeed within our province to dictate to anyone as to what he should do or what he should not do, but we cannot refrain from expressing our regret that so good an ornithologist as the author should have employed so much energy and time in a work of this character, which does little to advance the science in which he is so prominent and devoted a labourer.

What is Life? or, Where are we? What are we? Whence did we come? and Whither do we go? By Frederick Hovenden. (Chapman & Hall.) 6s. As the majority of people are rightly impressed with the complexity of the experiences and functions which are collectively referred to as "life," Mr. Hovenden's well-meaning efforts to reduce this complex expression to its simplest terms may, by those who judge books by their titles, be considered deserving of encouragement. An examination of the prolix argument, and perusal of the large amount of irrelevant matter contained in this volume, will, however, soon convince the reader that there are many things both in life and in Mr. Hovenden's explanations of it quite beyond comprehension.

The book, which comprises two hundred and eighty-four pages, is divided into three parts. The first of these consists of a statement of the case in two pages; the second is concerned with what the author calls the evidence proving the case; the third includes the deductions which Mr. Hovenden derives from the issue. The "statement of the case" is a bewildering succession of definitions of elementary truths and assertions which challenge contradiction. We have no space to multiply instances, but the following examples are typical of the uneven value of these statements:—"4. Time is the measurement of terrestrial motion." "9. All 'regeneration' arises from the influence of the prime factor, the ether, through which the inherent properties of the atom or molecule are made active. Hence, no ether, no regeneration."

In Part II. Mr. Hovenden succeeds in being interesting only when he confines himself to a description of well-recognized facts, and forgets his special mission. When he is possessed by the prophetic spirit he becomes impolite. Thus, on page 50: "The mathematician is so confident that his powers are absolute, and he is so dogmatic in his tone, that he is unapproachable. He stands alone, a monument of his own creation, in his own egotistical greatness." Or, page 53: "The public should study and grasp these ideas, which transcend the mind of the physicist, for the physicist has got into a fossilized condition; he will not move until that rising power, general intelligence, forces him." We trust that when this happens it will not mean the publication of more books after the nature of the present one.

We must refer the curious reader to the book for the contents of Part III. Mr. Hovenden becomes even more pronounced in his language when he speaks of the orthodox religious teachers of the time. On page 221, in dealing with the story of the fall of man, our author says: "What must we say, then, of priests who attempt to fossilize the mind within the limits of this grand *lie?—a lie which is damned.*" The italics are Mr. Hovenden's.

But we must leave this book, which Mr. Hovenden describes as his "contribution to the altruism which is to commemorate the jubilee of our beloved Queen Victoria," and as "the result of original experiments, earnest thought, of extensive reading, and of help from contemporary workers and thinkers. It is practically the work of a lifetime." We can only regret that the work of a lifetime should not have been better directed and more worthily employed.

The Sun's Place in Nature. By Sir Norman Lockyer, K.C.B., F.R.S. (Macmillan & Co. London, 1897.) 12s. The present work is, in the main, a republication of a series of "lectures to working men," given in 1894, at the School of Mines, by Sir Norman Lockyer, and which were published in *Nature* at that time.

We must at the outset enter our protest against the attacks upon one of the most eminent astronomers of the age which disfigure so much of the present book. They lower science and scientific men in the eyes of the public, and they tend to hide from the reader the real value of Sir Norman Lockyer's own work.

For if we could cut out from the present volume these unworthy attacks on Sir William Huggins, and the author's reiteration of his own infallibility—a good third of the book—we should have left a very large amount of most valuable scientific material, most of which has been the work of Sir Norman Lockyer himself or has been gathered under his superintendence. Prof. Lockyer's industry in the collection of facts and opinions is great, and this book, like the "Chemistry of the Sun" and the "Meteoritic Hypothesis," will be very useful as a work of reference.

The chief points dealt with in the work are, in the first book, the romantic story of the discovery of terrestrial helium; in the second, the demonstration that nebulæ and stars are but stages in one and the same evolution; the third book is an attempt to reinforce the meteoritic hypothesis from the observations of new stars; the fourth

and final book is a strong argument that we have, amongst the stars, cases not only of diminishing but also of rising temperature, and incidentally that our sun should be included in the former class. Had the work been confined to the setting forth of these four subjects it would have demanded a very considerable meed of praise, though Sir Norman Lockyer is always too much theory-ridden to be quite a safe guide to the student. A further and serious drawback to the book is that several of the most important diagrams are completely spoiled in the printing.

The Concise Knowledge Astronomy. By Agnes M. Clerke, A. Fowler, and J. Ellard Gore. (Hutchinson & Co. London, 1898.) 5s. A handbook of astronomy from three such writers might well be expected to be one of most unusual excellence, and, as a matter of fact, there can be no question but that they have produced a very useful and interesting volume. And yet, those to whom the deservedly high reputations of Miss Clerke and Mr. Gore are known, will scarcely avoid a feeling of disappointment. This is chiefly due to the untoward conditions under which these two gifted writers have had to work. To Miss Clerke are assigned two sections of the book—a history of astronomy and the section on the solar system. The former has been limited to thirty-six pages and has been marvellously well done within this contracted compass. It is true that it begins only with Hipparchus, omitting absolutely all reference to the astronomies of Chaldea and early Egypt, and the enforced rapidity of its glance gives no opportunity to the author fairly to exercise her research or her grace of style. In the third section, on the solar system, also entrusted to her, Miss Clerke has an ampler space, which she therefore uses to much better effect, but which is yet too confined for her subject. And we notice in not a few instances that an unfaltering verdict is given on subjects which are still before the court. No doubt, did space permit, the evidence for and against would have been fairly presented. We may mention as illustrations the rotation of Venus and the nature of the zodiacal light.

Mr. Gore in the fourth section, on the sidereal heavens, has brought together a vast amount of important information; but it is simply a reference book, carefully collated, well arranged—not a treatise.

Mr. Fowler, in section two, on geometrical astronomy and astronomical instruments, deserves unqualified praise, and has handled his subject in a clear, straightforward, businesslike manner. We may mention the conditions, number, and recurrence of eclipses, the "hunter's" and "harvest" moons, amongst many others as subjects which he has treated with special lucidity. We would only take some exception to the title "Geometrical Astronomy" as applied to his section, as the term so used is a little apart from its ordinary acceptance.

In conclusion the book is admirably illustrated by five fine plates and a number of clear diagrams. Its faults, which are few, are almost inseparable from the plan of such a handbook; and as carried out by its three authors the book is most thorough, trustworthy, and complete.

SHORT NOTICES.

Physiography for Advanced Students. By A. T. Simmons, B.SC. (Macmillan.) Illustrated. 4s. 6d. Intended for students preparing for the examinations of the Science and Art Department, this book is one of the best which we have seen for that purpose. There are many others in the field written on similar lines, but in this one a large section is devoted to geology—a subject which, in the new syllabus, has been considerably modified—and in many other respects the author has contrived to adapt his subject-matter to the latest requirements of that unstable syllabus of physiography which, ever since its first inception, has been undergoing a kind of metamorphosis that renders all books on the subject of an ephemeral character. Hence the never-ending procession of them, which, like Banquo's line of kings stretching out to the crack of doom, quickly follow on the heels of each other.

Elementary Physics, Practical and Theoretical. First Year's Course. By John G. Kerr, M.A. (Blackie.) Illustrated. 1s. 6d. Intended for organized science schools, this book deals with both practical and theoretical physics, and includes mechanics and hydrostatics for first year students. The treatment of the subjects is conventional, yet sound. The book will, no doubt, serve as a useful lever for the purpose of lifting students over the stile in those formidable examinations of the Science and Art Department.

We have received from Messrs. George Philip & Son a little book entitled "A Popular Introduction to the Study of the Sun," by George Mackenzie Knight, a very young man, who displays a wonderful insight into that complex subject—cosmography. Mr. Knight is already known as the author of a short history of astronomy. The work under notice is written in an eminently popular style, and, as the production of a young man only twenty years of age, it augurs well for the author's future as a man of letters. The book is inscribed to the late Mr. Ranyard, who took a friendly interest in the youthful astronomer's earlier work.

Remarkable Comets. By William Thynne Lynn, B.A., F.R.S. Sixth Edition. (Stanford.) 6d. The present edition of this little brochure is brought up to date. All the most remarkable comets from the earliest times up to the present day are here described. A list of comets which are expected to return during the next hundred years is inserted at the end of the book.

The Story of the British Coinage. By Gertrude Burford Rawlings. (Newnes.) Illustrated. 1s. Our author has presented the history of our coinage from the earliest times. Each coin is exactly described, and many of them are figured on both the obverse and reverse sides. Colonial coins also are included, and photographic reproductions given, the whole forming a very complete and handy guide to what may be called British numismatics.

BOOKS RECEIVED.

William Moon, LL.D., and his Work for the Blind. By John Rutherford, M.A. (Hodder & Stoughton.) Illustrated. 5s.

Cantor Lectures on Gutta-Percha. By Dr. Eugene F. A. Obach, F.I.C. (Society of Arts.)

A Student's Text-Book of Zoology. By Adam Sedgwick, M.A., F.R.S. (Sonnenschein.) Illustrated. 18s.

With Peary near the Pole. By Eivind Astrup. Translated by H. J. Bull. (C. A. Pearson, Ltd.) Illustrated. 10s. 6d.

The Free-Trade Movement. By G. Armitage-Smith, M.A. (Blackie & Son.) 2s. 6d.

Musical Statics. By John Curwin. New Edition. Revised by T. F. Harris, B.SC. (Curwin & Sons.) Illustrated. 3s. 6d.

A Simple Photographic Guide to the Choice of a Photographic Lens. By T. R. Dallmeyer. (Dallmeyer, Ltd.) Illustrated.

Elementary Chemistry. First Year's Course. By T. A. Cheetham. (Blackie.) Illustrated. 1s. 6d.

Practical Radiography. By A. W. Isenthal and H. Snowden Ward. Revised Edition. (Dawbarn & Ward.) Illustrated. 2s. 6d. net.

Notes on Observations. By Sydney Lupton, M.A. (Macmillan.) 3s. 6d.

Essays on Museums. By Sir William Flower, K.C.B. (Macmillan.) Illustrated. 12s net.

Radiography and the X Rays. By S. R. Bottone. (Whittaker.) Illustrated. 3s.

Meteorological and Magnetic Observations. (Stonyhurst College Observatory. 1897.)

The Barometrical Determination of Heights. By F. J. Cordeiro. (Spon.) 4s. 6d.

The Process of Creation Discovered. By James Dunbar. (Watts & Co.) 7s. 6d.

A Text-Book of Botany. By Drs. Strasburger, Noll, Schenck, and Schimper. Translated from the German by H. C. Porter, PH.D. (Macmillan.) Illustrated. 18s. net.

What is Science? By the Duke of Argyll. (David Douglas.)

Bibliography of the Metals of the Platinum Group. By Jas. Lewis Howe. (Smithsonian Miscellaneous Collections.)

The Mammals, Reptiles, and Fishes of Essex. By Henry Laver. (Simpkin, Marshall, & Co.) Illustrated.

XUM

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Notes from Dublin Bay.

Ruff.—On the 28th of August I obtained a pair of Ruffs in immature plumage, and also saw another one.

Curlew Sandpiper.—On the same day I saw large flocks of Curlew Sandpipers; one flock certainly could not have been less than five hundred strong. It passed quite close to me, the white upper tail coverts of the birds being very conspicuous, thus easily distinguishing them from the Dunlin when flying.

Avocet.—In the beginning of October I saw an Avocet, which stayed about the marshes till the last week in the month, but I failed to add him to my collection.

Albino Varieties of Mistle Thrush, Common Snipe, Woodcock, and Curlew.—The following is a list of the varieties which came under my notice last season.

Mistle Thrush.—October 5th; bluish white all over, showing the markings of the breast and throat. This seems a very persistent variety, as a winter seldom passes without two or three specimens coming under my notice. This, like all the other ones I have seen, was greatly frayed along the edges of the wings and tail. The owner informed me that it had been mobbed by other Mistle Thrushes for at least a month during which it was under his observation.

Common Snipe.—October 10th; perfectly white all over, eyes dark, bill and feet light yellowish brown. Obtained in Co. Meath. November 27th; whole plumage rich buff, the usual Snipe markings showing through. One of the commonest varieties of this species; usually get three or four in a season. Obtained in Co. Kerry.

Woodcock.—December 6th; whole plumage a beautiful buff, with a bluish sheen on wings and tail, bars and markings a bright brick red. Beak and legs reddish brown. From Co. Tipperary.

Curlew.—January 4th; whole plumage white, with usual markings showing against the white background; a most striking variety; bill and feet tan colour. Shot by Mr. Young, Brockley Park, Queen's County.—E. Williams, 2, Dame Street, Dublin.

Water Pipit (Anthus spipoletta) in Carnarvonshire.—At a meeting of the British Ornithologists' Club, held on January 19th, Mr. Howard Saunders exhibited an immature example of the Water Pipit which had been procured by Mr. G. H. Caton Haigh on December 3rd, 1897, in Carnarvonshire.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Science Notes.

At a recent meeting of the Members of the Institution of Electrical Engineers, Mr. Robert Hammond explained in detail a method by which electrical energy on a large scale will, at an early date, be generated and at the service of consumers. The cost, it is stated, will be such as to bring the electric light within the sphere of all light-users, as the distribution can be effected at the rate of about three farthings per unit.

Neptune's diameter, according to a recent determination by Prof. Barnard, is 32,900 miles.

Sections A to K of the British Association at the Bristol meeting in September next will be respectively presided over by Prof. W. E. Ayrton, f.r.s.; Prof. Francis R. Japp, f.r.s.; W. H. Huddleston, f.r.s.; Prof. W. F. R. Weldon, f.r.s.; Dr. J. Bonar; Sir John Wolfe-Barry, f.r.s.; H. E. W. Brabrook, c.b.; and Prof. F. O. Bower, f.r.s. Sir William Crookes, f.r.s., is the President elect, and he will deliver his address on Wednesday evening, 7th September. Prof. W. J. Sollas, m.a., f.r.s., and Mr. Herbert Jackson, will deliver the two evening discourses.

The third annual Congress of the South-Eastern Union of Scientific Societies, whose President is the Rev. T. R. R. Stebbing, will be held at Croydon, on June the 2nd, 3rd, and 4th. A number of interesting papers are to be read and discussed, among the contributors being Mr. J. W. Tutt, Mr. C. Dawson, Prof. J. Logan Lobley, Mr. Fred. Enoch (on the "Life History of the Tiger Beetle"), and Prof. G. S. Boulger, who will deliver the annual address, as President elect, on June 2nd. The hon. secretary is G. Abbott, m.r.c.s., 33, Upper Grosvenor Road, Tunbridge Wells.

As an indication of the interest centred in technical education, the vast sum of money raised for the Northampton Institute, Clerkenwell, is convincing. On the 18th March the Lord Mayor inspected and formally opened the buildings, which, together with the equipment, have cost upwards of £80,000. In addition, the land, generously given by the late Marquis of Northampton, is estimated to be worth not less than £25,000. Dr. Mullineaux Walmsley, the Principal, is a man of great experience in applied science, and a casual inspection of the programme of studies to be carried out under his direction augurs well for the artizan classes. Examinations (to youths and men of this class) are a bugbear, and it is gratifying to note that this institute provides courses of lectures and demonstrations for nearly all trade subjects at twopence per lecture, without any stipulation as to examination for the purpose of grant earning.

Letters.

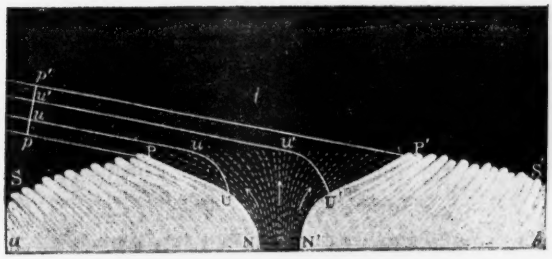
[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE LEVEL OF SUNSPOTS.

To the Editors of Knowledge.

Sirs,—The instructive article on "The Level of Sunspots," by the Rev. Arthur East, in your last issue, part of which dealt with the probable refraction of the umbra by the vapours on the solar surface within the spot cavity (an opinion which he has already expressed in a recent paper to the British Astronomical Association), is interesting from the fact that the late R. A. Proctor had arrived at the same idea many years ago. In Proctor's "Old and New Astronomy," on page 381, the figure (257) is sufficiently ex-

planatory as embodying this idea; and on page 382 the footnote reads:—"In Fig. 257 I indicate a way in which the width of the penumbra on the side furthest from the sun's edge (occasionally equal to the width of the side



Ideal Vertical Section of a Sunspot in the earliest stage of its development.

nearest to the edge) may be explained by the refractive action of the vapours within the spot cavity. The lines Pp, Uuu, U′u′u′, and P′p′, are supposed to be lines of sight from the earth when the spot is viewed aslant."

We must, however, thank the Rev. A. East for the beautiful experimental illustrations of this point.

From the satisfactory way this theory simplifies many of the difficulties connected with spot phenomena, it is somewhat surprising that it has not found its way into more general favour and recent text-books.

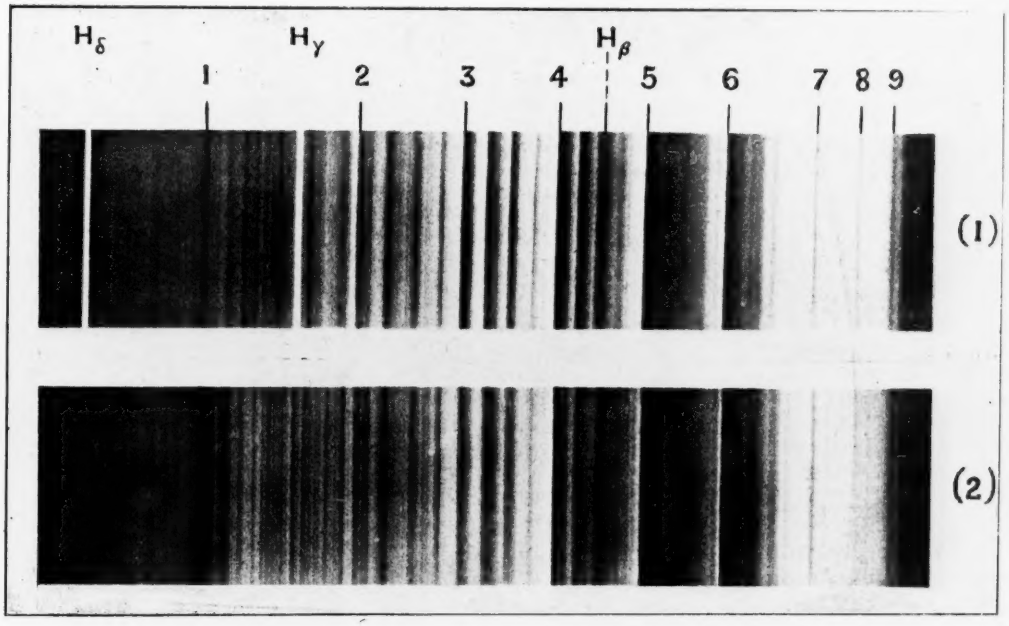
WM. SHACKLETON.

Royal College of Science, London,
April 11th, 1898.

PHOTOGRAPHED SPECTRA OF ο CETI AND α HERCULIS.

By the kindness of the Rev. W. Sidgreaves we are enabled to give the accompanying reproduction of two beautiful photographs of these most interesting stellar spectra, obtained at the Stonyhurst College Observatory in December and February last. The spectra are on the same scale as that of ο Ceti given in the number of KNOWLEDGE for March (page 61), but are prolonged a little in both directions, extending, in the orange, below the D lines; and the reference numbers to the great absorption bands, accidentally displaced in the earlier reproduction, are here given in their proper places.

The juxtaposition of the two spectra brings out clearly their very significant likenesses and differences. Under the former head comes the series of great fluted absorption bands which forms the distinguishing feature of this stellar type. Under the latter may be noticed the greater structural detail in the bands of α Herculis, the presence of numerous fine lines, and the appearance, whether actual or a mere contrast effect, as of a very bright line to the blue of the sharp edge of the dark bands, especially of bands four, five, and six. The spectrum of ο Ceti, on the other hand, is especially distinguished by its two bright lines of hydrogen, γ and δ. The comparison of the two spectra at the places of the three hydrogen lines renders more distinct the relationship of these to the rest of the spectrum, and emphasizes the remarkable fact of the absence of the third line, Hβ; the line which we should have rather expected to show its presence with the greatest plainness.—E.W.M.



Photographed Spectra of ο Ceti (1), 1897, December, and α Herculis (2), 1898, February.

	λ		λ		λ
1	= 4227.	4	= 4757.	7	= 5447.
2	= 4420.	5	= 4951.	8	= 5597.
3	= 4581.	6	= 5162.	9	= 5756.

Stonyhurst College Observatory.

A BRILLIANT METEOR.

To the Editors of Knowledge.

Sirs,—Last night at 10.20 I saw an extremely brilliant meteor, which appeared a little south and east of Procyon, and disappeared quite at the zenith. In spite of the bright moonlight it was a very conspicuous object of bluish white colour; its course appeared (perhaps from my point of view) to be quite straight, and occupied about five or six seconds of time. It seemed simply to "go out" at last, without explosion, sparks, or anything else.

April 6th, 1898. G. Northover Stretton.

MERCURY.

To the Editors of Knowledge.

Sirs,—I think it may possibly interest some of your readers to know that I observed Mercury to-night, unassisted, except by a mental knowledge of its R.A. and Dec., at the short interval of seven minutes only after sunset, from my window at King's Cross. Is not this a record for a London view? It was conveniently observable until 7.50 p.m., except at infrequent intervals, when it was obscured by stray clouds. C. B. Holmes.

April 12th, 1898.

P.S.—It was between three and four minutes to seven when it first revealed itself.

NATURE'S FINER FORCES.

SOME NOTES ON OLD WORK AND NEW DEVELOPMENTS.

By H. Snowden Ward, f.r.p.s., *Editor of "The Photogram."*

It is rather difficult to find a title for an entirely new subject which is still in its early days of investigation, and to which its pioneer has given no name. It is all the more difficult when three or four unauthorized persons have undertaken to christen the subject, when its scientific basis is uncertain, and when there is a suspicion that it may be closely allied to an older class of results which have a recognized title. The subject of the Bakerian Lecture before the Royal Society this year is extremely interesting, because it opens up a field of investigation in which the results are surprising and curious, while the methods are so simple and the requisites are so cheap that it is possible for anyone to take up the work and to carry the results a few stages further.

Dr. W. J. Russell gave his lecture the non-committal title of "Experiments on the Action exerted by Certain Metals and Other Bodies on a Photographic Plate"; and journalists who have recorded his results have given the subject such titles as Scotography (apparently because this is the name of a method of teaching the blind to write), Vapography (because the phenomena *may* be the result of vapour given off from the metals, etc.), and other equally appropriate titles.

Before dealing with Dr. Russell's observations it may be well to recall one or two older phenomena which do not seem to have been referred to in the discussion on Dr. Russell's lecture, but which may have a distinct connection with his work.

A common phenomenon, familiar to students, and even to many schoolboys, is the formation of "breath figures" upon a mirror, a piece of plate glass, or, better still, a polished metallic reflector. On the polished surface, which should be cold, lay any small object such as a coin. While this is in position breathe on the polished surface. Afterwards, for days and sometimes even for weeks or months, the image of the object may be restored by again breathing upon the polished surface; and this may be done repeatedly, even though the surface be well cleaned and polished.

A possibly kindred effect may be seen on windows to the inside of which a printed placard has been affixed. Though the printing ink does not touch the glass, it will be found, after the placard has been exposed for some time, that the window has acquired the property of condensing moisture on the parts near the printing ink of the placard differently from its condensation on other parts. And this property will remain for weeks or months, through repeated cleanings of the window.

In the early forties, M. Moser, of Konigsberg, and Robert Hunt, the British investigator on light, reported some extremely interesting experiments on the effects of contact between various substances and polished metallic plates; and after long, patient research Hunt attributed the results to difference of temperature, and called the process Thermography. He even went so far as to anticipate that the process might prove more valuable than photography when fully developed.

Hunt, working in the days of the Daguerreotype, when the photographic image was developed upon a metallic plate by means of vapours, applied the same method to the development of his thermographic images, with the result that he got strong and permanent representations of the objects laid upon his metallic plates. He found that dissimilarity in the objects and the polished plates was necessary; for instance, gold and silver coins gave good images on a copper plate, while copper coins did not act on copper. He noted further that the mass of the receiving plate affected the result, and that better images were made upon a large than upon a small sheet of copper, Using various pieces of glass, mica, tracing paper, etc., it was found that while some of the glasses and the tracing paper gave strong images, other glasses made little or no impression, and the mica left no trace. It was found that some objects of which no trace could be developed with mercury vapour gave good images with the vapour of iodine.

The later experiments bring us nearer to the results shown on dry plates by Dr. Russell, for Hunt found that objects separated from the metallic plate by air space of half an inch, or more, were capable of strongly impressing it after one night's exposure, and that a deal box acted very strongly. Further, that printed paper acted on the plate to such an extent that very good copies of any printed matter could be made, and it was in this direction that Hunt suggested the first practical application of Thermography.

Another set of observations, received with scorn by most of the scientific men of their day, but confirmed in 1883 by a committee of the Psychical Research Society, were those of Reichenbach, on what he called "odic force," a property which he found to emanate from almost all substances. Most of Reichenbach's observations were made by means of sensitive patients, who stated that they could see luminous emanations from various metals, etc.; and it is unfortunate that he did not carry out to a considerable extent his experiments with photographic plates — on which he did find results after the very few experiments made. I mention Reichenbach's work because his patience in research and verification was enormous, and his book ("Researches on the Dynamics of Magnetism") is full of reports of very suggestive experiments—researches which might now be repeated with lenses and photographic dry plates, with, perhaps, good results in the light of the recent work of Dr. Russell.

Scattered through the pages of the photographic journals are many reports of single observations, and short series of experiments on similar lines to those of Dr. Russell, and the results have been variously ascribed to heat, to X rays, to magnetism, to "dark light," etc.; but it seems to have been left to Dr. Russell to carry out a comprehensive series of experiments, and to—in some measure—raise the veil which has hitherto shrouded these phenomena in obscurity.

Dr. Russell found, incidentally, and in the course of experiments for another purpose, that zinc, if placed in contact with a photographic dry plate, had some action upon it which would enable it to be developed as if it had been exposed to light; and, further, that a similar action was exerted by many other metals, by wood, by strawboard, by many printed papers (which would leave a clear impression of their printed matter), etc., etc. All these results he detailed in a paper before the Royal Society about a year ago; and in the meanwhile he has been repeating, verifying, and extending his observations, with the results which were brought forward in the recent Bakerian Lecture. At first the zinc and other materials were placed in contact with the photographic plates, and it was found that after a week's contact an image could be developed which would plainly show such minute marks as scratches on the zinc; that the structure, rings of growth, etc., in a section of a pine tree, and even the grain of mahogany which had formed part of a piece of furniture, and had been practically in darkness for a couple of centuries or more, were also plainly visible; and that not only the printing, but also the water-marks and accidental defects on certain papers, could be developed on the plates. When the objects were placed at a little distance from the dry plate (gradually increased to an inch or more) the effect was still produced, but, of course, without any detail being visible. Not only would the action thus pass through an inch or more of air, but it also passed easily through gelatine, celluloid, collodion, and gutta-percha tissue. Glass was found to be quite impervious, though, curiously enough, glass was pervious to the emanation from some of the uranium salts which were tested, and which acted very strongly, whether in the dry state or in solution. This point is important, since it shows that there are at least two classes of emanation; and other experiments point to the possibility of there being several more.

Amongst the most active metals are zinc, magnesium, aluminium, nickel, lead, and bismuth. Cobalt, tin, and antimony are less active, while copper and iron are practically inert. Strawboard and fresh charcoal act very strongly upon the plate, as does copal varnish, even when quite dry and hard. In the earlier experiments mercury seemed to be one of the most energetic agents, but it had since been shown that pure mercury was inactive, and that the effects observed were due to zinc and lead contained as impurities.

With zinc, which is one of the most satisfactory subjects for experiment, it is found that the action is strongest when the face has recently been brightened (as by cleaning with emery paper), and that old zinc, which is considerably oxidized, has practically no effect upon the plate.

The possibility of the action being due to what may be called latent light was suggested, but Dr. Russell finds that the action is the same whether the active substance has been recently insulated or has long been kept in complete darkness.

The action of temperature is very important, and while the necessary exposure for a good impression is usually about a week (at a temperature of fifteen degrees Centigrade), an increase of temperature to fifty-five degrees will reduce the exposure to a few hours.

As to the cause of these results Dr. Russell does not speak with certainty, but he has made many experiments which confirm his idea that the effects are due to vapours given off by the objects. On this point a great deal of additional work is needed, especially in view of the significant facts that the most volatile metals are not the most active; that some oils and gums (such as turpentine and copal) will act strongly, while volatile substances like alcohol and ether have no effect; that the uranium salts act strongly through glass; and that a book printed so long ago as 1641 still gives a faint impression, while one dated 1805 gives a strong impression on the plate. If the results are due to a vapour it will be interesting to know the conditions under which it can continue to be given off through two hundred and fifty years.

Altogether the field of research is most attractive and promising, and the publication of Dr. Russell's results should lead very many investigators to take it up. If they do, I trust we may have more careful observation and less hasty publication than was revealed by many of the announcements made soon after the publication of the work of Prof. Röntgen.

BOTANICAL STUDIES.—III.

JUNGERMANNIA.

By A. VAUGHAN JENNINGS, F.L.S., F.G.S.

OUR last study* dealt with a type of fruit formation which is about the most highly developed among the lower cellular plants. In *Coleochæte*, while the vegetative part of the plant consisted of a simple cell-plate, it was noted that the reproductive process was far more specialized than that in the first type, *Vaucheria*.† It was observed that the egg-cell (or *oösphere*) after fertilization became surrounded by a layer of cells developed from adjacent tissues, and also that it subsequently divided into a number of separate bodies (*carpospores*), each of which could give rise to a new plant like the parent.

It is evident that both these modifications of the method of reproduction are of great advantage to the chances of survival of the plant. Not only is the egg-cell more protected in its resting stage, but by dividing into several independently living portions the probabilities of preservation of the type become vastly increased. Those genera in which the liberated carpospores have the greatest activity and the best power of resistance are those which will survive and multiply.

In the algæ, and certain fungi which are probably their degenerate descendants, this seems to be the highest stage reached in the evolution of "fruits" and the phenomenon of "*alteration of generations*." When we look for the next step there is a great break in the series, and one which we shall probably never be able to bridge over satisfactorily. There seems every reason to suppose that the early stages in the evolution of the higher plants resulted from the spreading of simple aquatic forms on to the land, their attempt to gain a footing there, and to adapt themselves to terrestrial conditions.

What the intermediate stages were there is no evidence to show. Delicate cellular plants have practically no chance of preservation in the rocks of the earth's crust, and geological science can give no help. The only available method of investigation is the study and comparison of living forms: their life history, and early stages of development.

* KNOWLEDGE, March, 1898. † KNOWLEDGE, January, 1898.

XUM

There would seem to have been three alternatives open to the water plants which invaded the land. In the first place they might perhaps accommodate themselves to living under terrestrial conditions without undergoing much structural change. So long as moisture is abundant enough at times, a plant can, as it were, learn to do without it at others. It can live through times of dryness, and complete its life history when proper conditions are prevalent. Thus the simpler forms of the green and the blue-green algæ can be found in salt water, in fresh water, and on damp earth, trees, or brick walls; and even such highly developed forms as *Chroölepus* and *Phycopeltis* are distinctively land plants, though retaining all their algal characters. One is liable to forget that a very thin layer of moisture is sufficient in proportion to the actual size of these living cells: a consideration of much importance in connection with the reproduction of terrestrial cryptogams.

Other algal forms seem to have accommodated themselves to earthly life, even under conditions of extreme dryness, by entering into a mutual contract with certain fungi, and establishing the type of plants we know as lichens. This story is a biological romance in itself, but for the present outside our line of study.

The third alternative was the gradual change of the structure of the plant, so as to render it more capable of existence and propagation under altered circumstances.

In this process of accommodation of the plant to new conditions it became advantageous to develop parts which could penetrate the soil and absorb moisture and partial nutriment from it, as well as to raise some parts above the original level, to be sure of their reaching the sunlight. Thus in time resulted the well-defined distinction of root, stem, and leaf, with which we are naturally familiar.

The simplest of terrestrial plants—using the term for those distinctly modified for living on ground, as distinct from algæ—are the *Hepaticæ* or *Liverworts*. They can be found everywhere, on damp banks or rocks or tree-trunks, and they present a beauty and variety of structure that makes them a fascinating study to the microscopist.

There are the wide-spreading lobes of the flat thallus of *Marchantia* and its kin, to be found on moist banks everywhere; and in mossy places in the springtime the slender leafy branches of the *Jungermannias* grow and fruit with a fresh luxuriance which renders them, in the opinion of many, more attractive than their drier and hardier cousins, the mosses. It is unfortunate that names of such Teutonic clumsiness as Liverwort and Jungermannia should be applied to so graceful a group; but the necessities of scientific nomenclature oblige us to retain them.

So far as the vegetative part of the plant is concerned, the different genera do to some extent bridge over the space between the mosses above and the algæ below. Though in *Marchantia* the thallus has a structure so specialized as to show at once how widely it is separated from a simple seaweed, there are other forms, like *Riccia* and *Anthoceros*, in which the thin, green, plate-like thallus seems but little different from *Coleochæte*.

Yet all the forms included in the *Hepaticæ* differ from lower plants and agree with all higher cryptogams in the fact that the most essential part of the reproductive system is an "*archegonium*." So constant is this organ that the liverworts, mosses, ferns, and fern allies are now often grouped together under the name "*Archegoniatæ*."

An *archegonium* is a flask-shaped structure containing the oösphere. Its lower part is an oval chamber in which the egg-cell lies, and is prolonged upward into a neck composed usually of four columns of cells round a central axis. As the egg-cell becomes mature the cells of the central axis degenerate, so that a canal is formed full of a mucilaginous material, which projects also at the top of the neck.

The *antheridia* are little round or oval bodies occurring at the bases of the leaves of the same or a separate shoot. Their interior cells divide up into numerous minute *antherozoids* (or *spermatozoids*) which are capable of swimming by means of a pair of delicate cilia. They are, of course, so minute that even a raindrop is amply sufficient to enable them to reach the archegonia. When this occurs some of them enter the mucilaginous cap at the end of the neck, and, making their way down the canal, effect the fertilization of the oösphere.

Hepatics, then, differ from even the highest of thallophytes in the fact that the egg-cell is, even before fertilization, contained in a special structure intended not only for protection, but also modified to assist in the process of fertilization.

It might be expected that this advance in the preliminary stages would be followed by a corresponding elaboration of the fruit structure, but such is not the case. In aquatic types, such as *Coleochæte*, the resting stage seems to be a necessity to the oöspore in view of the future free-swimming life of the unprotected carpospores.

In a land plant, on the other hand, the swimming powers of the carpospores would be of little use in comparison with the far wider distribution attainable by the help of the wind. If the spores developed protective coats of their own they would be capable of considerable resistance to adverse conditions, and this appears correlated with a decreasing necessity for a resting stage of the oöspore.

Accordingly, what takes place after fertilization is an almost immediate enlargement of the fertilized egg-cell, and its commencing internal division into spores. At the same time the cells below it grow down into close connection with the tissues of the parent plant, forming a structure known as the *foot*. So that the spore-bearing generation or *Sporophyte* adopts the method of remaining in connection with its parent plant till it is ready to liberate its spores; instead of, as in the algæ, preparing itself to keep alive for a time after the parent plant has died down. In this way it differentiates itself into a *foot* which remains in connection with the parent tissues, a *seta* or stalk which grows upward, and a globular *sporangium* or *capsule* carried at its apex. The whole is thus not a fruit, but almost a second or alternative plant dependent on the first. It has no roots, leaves, or green colour (*chlorophyll*), and therefore cannot exist as an independent plant, but is nevertheless on the road to become one.*

The further stages in the life history differ, of course, in different genera, but the main features are remarkably uniform throughout the group.

The neck of the archegonium withers after fertilization of the egg-cell. Its wall enlarges for a time with the growth of the oöspore, but finally splits at the top, leaving a sheath, termed the *vaginula*, round the base of the upgrowing sporophyte.

The tissues of the *sporangium* itself become differentiated into an outer two-layered wall and an inner cell-mass or *archesporium*. It is in the further development of the latter that we meet with the most striking difference from the corresponding organ in algæ, and the most evident modification for terrestrial conditions. The cells divide up into a large number of smaller ones, and while some of these develop into *spores*, the remainder change into long sterile threads termed *elaters*. The latter are long filaments

* In one very interesting group of the *Jungermanniaceæ*, the archegonia are carried in a sac-like structure hanging down from the stem, and in some cases this may bury itself in the soil and even attempt to root itself.

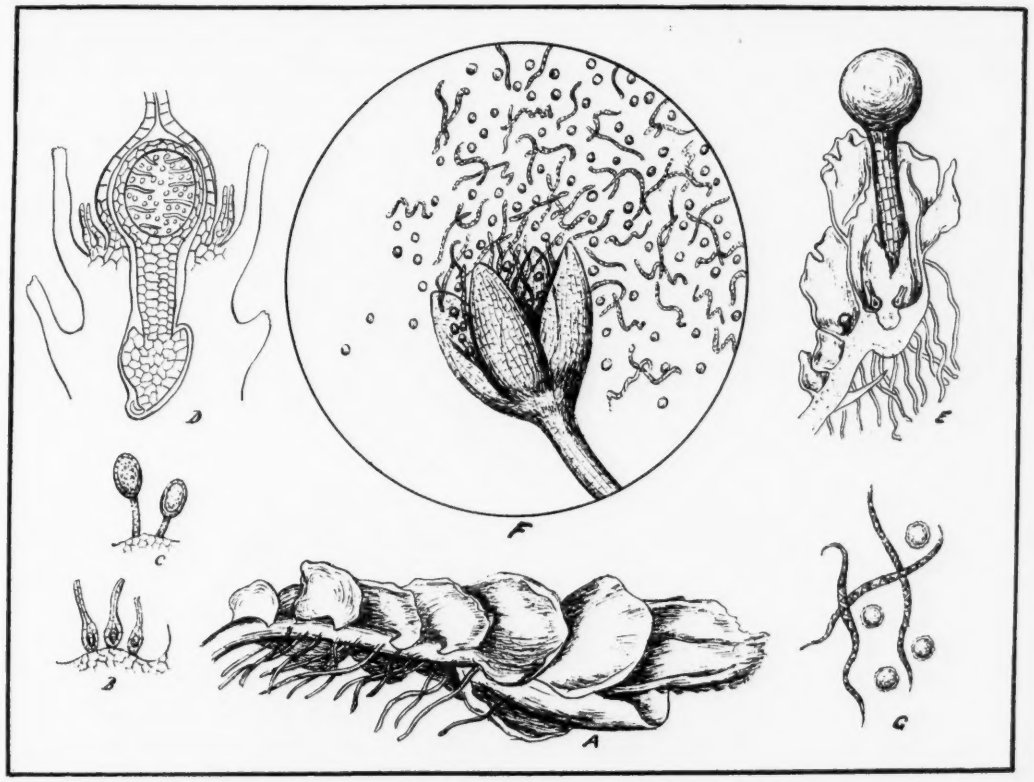
pointed at the ends, and possess a single or double spiral thickening-band. Their elasticity and response to changing conditions of moisture and dryness assist very much in the dispersal of the ripe spores.

Both spores and elaters are formed while the capsule is still surrounded by its "perianth," and the upgrowth of the seta commences later and takes place with great rapidity. Finally, when atmospheric conditions are suitable the capsule bursts, and in the *Jungermanniaceæ* always divides into four valves. Spores and elaters are thrown out and dispersed together. In some genera a number of elaters remain attached at one end to the tips of the segments of the capsule, but in the genus which forms the subject of our illustration they are all free. It is very interesting to note that, while the mosses and ferns dispense with this assistance to the liberation of the spores, it should occur in such different groups as the liverworts and the horsetails. Further, that a similar phenomenon is seen in those strange fungi, the Myxomycetes; and that a somewhat similar mechanism is employed in dispersing the seeds of some flowering plants.

The spores themselves are small spherical bodies with a single or double wall. Under suitable conditions the inner wall, when there are two coats, breaks through the outer, and the contained protoplasm grows out into a cell-plate or a cell-thread (*protonema*), which then buds out into a new plant and develops its own archegonia.

This protonema stage seems to be a "reminiscence" of the algal ancestor, but it is curious that it is far less evident here than in the true mosses, as will be seen later.

Meanwhile the parent egg-bearing plant or oöphyte may still continue to exist, and throw out fresh shoots to bear a new generation of archegonia and antheridia.



A.—The end portion of a shoot of *Nardia crenulata*, a simple type of the leafy Hepatics. The terminal leaves differ from the rest, and form a *Perianth*, at the base of which the reproductive organs are developed. B.—Archegonia of one of the leafy Hepatics (*Calobryum*). C.—Antheridia of the same. D.—Microscopic section through the apex of a shoot of a similar type (*Jungermannia*). Two unfertilized Archegonia are shown; one on each side. In the centre is the young "*Sporophyte*," resulting from the fertilizat on of a third Archegonium. The archegonial wall still remains as the *Calyptra*, with the lower part of the neck, but has enlarged with the growth of the Oöspore. The latter is already undergoing internal division to form Spores and Elaters. E.—The apical portion of a shoot of *Nardia*, showing an Antheridium and two unfertilized Archegonia. In the centre is the *Sporophyte*, consisting of a globular *Sporangium* carried up on a Stalk or *Seta*, and sheathed at the base by the remains of the Archegonium. F.—A ripe Sporangium or Capsule of *Radula complanata* at the moment of dehiscence, showing the splitting of the wall into four valves, and the ejection of the numerous Spores mixed with Elaters. G.—Spores and Elaters magnified. (A and E, after Engler; D, after Hofmeister; B and C, after Göbel.)

If, then, we summarize the results of our study of the liverwort, regarding especially the mode of reproduction and the interrelationship of the two stages of its life, we arrive at some such conclusion as this:—

When the water algæ tried to live on land some of them were able to do so with little change of structure and still retain their primitive character. Others gradually advanced by a specialization of the reproductive process and the evolution of archegonia, whether or not accompanied by increasing complexity of the thallus. This advantage in the life struggle was followed up by the persistence of the connection between the fertilized egg-cell, with its resulting growths, and the parent plant; just as the evolution of

mammals has gone side by side with the progressive dependence of the young on the mother.

At the same time, the formation of spores with a strong protective coat became a necessity under the new conditions, and the accessory assistance of the elaters became of much value in securing the wide dispersal of the spores.

In the liverworts we have, in fact, an indication of a tendency on the part of the spore-bearing generation to assert itself as an independent plant. It will be our business in our future studies to try to discover what has been the result of this tendency, and along what lines it has acted.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

New Comet.—A bright comet was discovered by Mr. C. D. Perrine, of the Lick Observatory, Mount Hamilton, on the night of March 19th. The position of the comet was at R.A. 319° 39′, Dec. 16° 48′ N., and it was moving rather quickly to the north-east. Its brightness was estimated as of the seventh magnitude, the diameter of the coma was two minutes, and it had a tail about one degree in length. Elements were computed by Ristenpart and by Hussey and Perrine, from which it appeared that the comet had just passed its perihelion, and was receding from the sun and earth. From observations between March 19th and 31st, Kreutz, of Kiel, gives the following elements:—

Perihelion passage	1898, March, 17·37558		
	°	′	″
Longitude of perihelion ...	310	8	11·7
Longitude of ascending node	262	33	59·6
Inclination	72	27	48·1
Perihelion distance ...	1·0986		

The perihelion place of the comet occurred, therefore, at a distance of about nine millions of miles outside the orbit of the earth. The position of the comet will be as follows:—

Ephemeris by F. Möller, for Berlin, Mean Midnight.

	R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.	Brightness.
May 4	0	53	16	+51	57·4	177	0·47
,, 8	1	15	0	+53	14·7	182	0·42
,, 12	1	36	25	+54	16·3	188	0·38
,, 16	1	57	18	+55	2·5	193	0·33
,, 20	2	17	30	+55	36·6	198	0·30
,, 24	2	36	52	+55	59·9	204	0·27
,, 28	2	55	20	+56	14·1	209	0·24
June 1	3	12	49	+56	20·5	214	0·22
,, 5	3	29	19	+56	20·7	219	0·20
,, 9	3	44	51	+56	15·8	224	0·18
,, 13	3	59	25	+56	7·0	229	0·16

On April 30th the comet will be placed three degrees south of the star ζ Cassiopeiæ (magnitude 3·7). On May 6th it will be two degrees south of θ Cassiopeiæ (magnitude 4·4), and for a few nights, about May 18th, will be very near the great star cluster in Perseus.

Encke's Comet.—This well-known periodical comet will pass its perihelion on May 24th, but will not be visible at that time, as it is near ζ Tauri, and only about twenty degrees east of the sun. In June the comet will move rapidly southwards, and will approach the earth to within about twenty-three millions of miles on July 3rd, so that it will be a fairly conspicuous object to observers in the southern hemisphere.

Cometary Discovery.—At the last meeting of the British Astronomical Association, on March 30th, Mr. Crommellin, of the Greenwich Observatory, made some remarks rather derogatory to English observers in regard to discoveries of comets. His strictures appear to be quite justified by the facts, for there is no reason why nearly all the prizes in this field should be carried off by Americans. In view of the large number of capable observers, it is certainly a very remarkable circumstance that so few comets are discovered in this country. The climate cannot be blamed for it. Either observers do not thoroughly pursue the work of sweeping or there must be something wrong with their instruments or methods. The work itself is easy and requires no great skill, the chief things essential to success being patience and perseverance. But a man's individual observational capacity comes in as an important factor, for small, faint, and difficult comets would again and again elude detection by a poor observer. It is hoped that some English amateurs will give their earnest attention to this department. They would find it equally interesting, and in the end more profitable, than observing the moon, planets, and double stars.

Recent Fireballs.—On March 29th, 8h. 51m., a fine slow-moving meteor, not quite as bright as Jupiter, was observed by Mr. A. King, at Leicester. It had the appearance of a bright green star, followed by a red tail three and a half degrees in length. Its path was from 124¼° +1½° to 97½°−12°, and duration of flight about equal to four and a half seconds.

On April 4th, 10h. 35m., a very brilliant meteor was seen by Mr. J. H. Preston, of Fishponds, near Bristol. It fell in a very oblique path from east to west. The nucleus appeared to be of the size of a fairly large orange, and at the end of its flight it apparently exploded into a large number of fragments.

On April 5th, 10h. 15m., a large meteor, brighter than Venus, and with a remarkably slow movement, was observed by the Rev. T. E. R. Phillips, at Yeovil. He says: "It was of a beautiful golden yellow or orange colour, and left a train of sparks behind. One can hardly conceive of what its splendour would have been had there been no moon. It travelled through a hundred degrees of longitude so far as I traced it, and I probably missed the beginning and certainly missed the ending, as the meteor dropped behind some houses. Owing to the brilliant moonlight it was difficult to determine its position with accuracy. I first caught it near η Leonis, and followed it as far as a point a little below δ Herculis. The duration of flight was twelve to fifteen seconds, and position of the path from 154°+17° to 260°+22°." The same object was seen by Mr. Vaughan Cornish at Bournemouth. He gives the time as 10h. 17m., and says the meteor was quite as bright as Venus at her maximum. The nucleus had a sensible diameter and a deep yellow colour. It threw off a short train. The observed part of the path was very nearly vertical, and extended over about twelve degrees, ending three degrees to the right of Vega, and about half a degree lower than that star. "The finish up of the meteor was like that of a burning body being extinguished; it did not end with a burst." Mr. P. M. Ryves, of Stone, Staffordshire, also witnessed the appearance of the meteor, and gives the time as 10h. 10m. He describes it as travelling from south-west to south-east in a very nearly horizontal flight, and with extreme slowness. There was no train, but a fragment behind and in front. The duration was from twenty to thirty seconds, but may have been much more as he did not see the beginning. The exact path was from 151°−9° to 199°−19°.

From a careful comparison of these observations it appears that, when first seen, the meteor was situated at a height of eighty-nine miles above a point in the English Channel about twenty-five miles south-east of Dartmouth. Moving very slowly to the north-east it entered upon the English coast near St. Alban's Head; then, successively passing over Bournemouth, Southampton, Alton, and Aldershot, it finally disappeared at an elevation of twenty-

five miles over a point five miles north-east of Bisley. The flight was directed upon an earthpoint at Braintree in Essex, and, seen from this district, the object must have appeared stationary in the heavens. The whole length of its observed flight was one hundred and sixty-two miles, and if the time of its duration is considered to have been fifteen seconds its velocity must have been only eleven miles per second. The radiant point was in Monoceros at 121°−1°, but it does not correspond with that of any known meteoric shower. This fireball was an exceedingly interesting one from its brilliant aspect, and long, graceful flight, and it is also notable as a typical specimen of the very slow-moving and isolated meteors often directed from radiants low in the western sky.

THE FACE OF THE SKY FOR MAY.

By HERBERT SADLER, F.R.A.S.

THE minimum period of sunspots has not arrived yet.

Mercury is a morning star, and is in inferior conjunction with the Sun on the **1st**. On the **14th** he rises at 3h. 49m. A.M., with a northern declination at noon of 10° 51′, and an apparent diameter of 11″. On the **21st** he rises at 3h. 31m. A.M., or about half an hour before the Sun, with a northern declination of 10° 42′, and an apparent diameter of $9\frac{1}{2}''$. On the **31st** he rises at 3h. 9m. A.M., or about three quarters of an hour before the Sun, with a northern declination of 13° 20′, and an apparent diameter of $7\frac{1}{2}''$. He is at his greatest western elongation on the **28th**. While visible he describes a direct path in Aries, without approaching any very bright star very closely.

Venus is well placed for observation as an evening star. On the **1st** she sets at 9h. 9m. P.M., or one hour and three quarters after the Sun, with a northern declination at noon of 20° 24′, and an apparent diameter of $10\frac{1}{2}''$. On the **11th** she sets at 9h. 38m. P.M., or about two hours after the Sun, with a northern declination of 22° 57′, and an apparent diameter of 11″, about ninety-three one-hundredths of the disc being illuminated. On the **21st** she sets at 10h. 2m. P.M., with a northern declination of 24° 25′, and an apparent diameter of 11″. On the **31st** she sets at 10h. 18m. P.M., or about two hours and a quarter after the Sun, with a northern declination of 24° 44′, and an apparent diameter of $11\frac{1}{3}''$. She will be occulted by the Moon on the afternoon of the **22nd**, the disappearance taking place at 6h. 54m. P.M., at an angle of 115° from the vertex, and the reappearance at 7h. 32m. P.M., at an angle of 184° from the vertex; of course, in both cases, before sunset.

Mars is, for the purposes of the amateur, invisible.

Jupiter is an evening star, and is still very well placed for observation, rising on the **1st** at 3h. 20m. A.M., with a northern declination of 0° 52′, and an apparent equatorial diameter of 43″. On the **7th** he rises at 2h. 54m. P.M., with a northern declination of 1° 1′, and an apparent diameter of $42\frac{1}{2}''$. On the **14th** he rises at 2h. 24m. P.M., with a northern declination of 1° 8′, and an apparent diameter of 42″. On the **21st** he rises at 1h. 56m. P.M., with a northern declination of 1° 11′, and an apparent diameter of $41\frac{1}{3}''$. On the **31st** he rises at 1h. 15m. P.M., with a northern declination of 1° 10′, and an apparent diameter of $40\frac{1}{2}''$. During the month he describes a retrograde path in Virgo without approaching any naked-eye star.

Saturn is in opposition to the Sun on the **30th**, but his southern declination is so great as to prevent any satisfactory observation of him in these latitudes, and the same remarks apply to Uranus. Neptune is invisible.

There are no well-marked showers of shooting stars in May.

The Moon is full at 6h. 34m. A.M. on the **6th**; enters her last quarter at 9h. 36m. P.M. on the **12th**; is new at 0h. 58m. P.M. on the **20th**; and enters her first quarter at 5h. 14m. P.M. on the **28th**.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solution of April Problem.

(By A. C. Umlauff.)

Key-move.—1. Kt to Kt7.

If 1. . . . K to Kt3, 2. Q to K8ch, etc.
1. . . . Kt to B4, 2. Kt to K5ch, etc.
1. . . . Any other, 2. Q to K6ch, etc.

[There seems to be a dual after 1. . . . Kt to Kt7 which has escaped notice.]

CORRECT SOLUTIONS received from Alpha, B. Goulding Brown, W. de P. Crousaz, Capt. Forde.

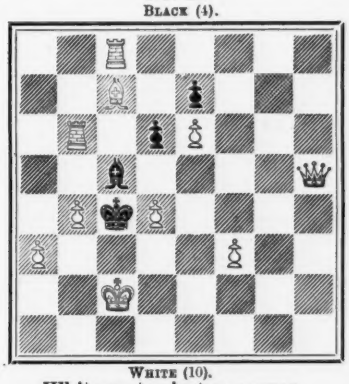
A. C. Challenger.—Many thanks for the problems, which shall appear shortly. Much regret your abstention in the other matter.

PROBLEMS.

By P. G. L. F.

No. 1.

BLACK (4).

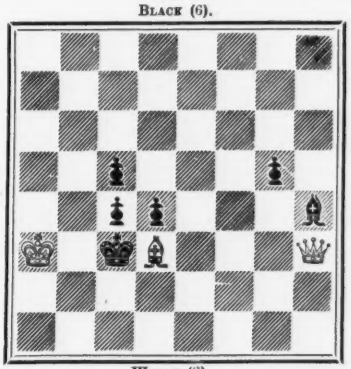


WHITE (10).

White mates in two moves.

No. 2.

BLACK (6).



WHITE (3).

White mates in three moves.

CHESS INTELLIGENCE.

The Cable Match between teams representing the British Isles and the United States was played on March 18th and 19th, an exciting contest resulting, as last year, in a victory for the British team by the odd game. It will be noticed that the three American players new to these contests (at boards Nos. 8, 9, and 10) met with no success. Our opponents would, perhaps, as they seem inclined to admit, have done better to rely on well-tried players, even at the risk of complaints as to the "New York clique." The following is the score :—

Great Britain.		America.	
J. H. Blackburne (London)	½	H. N. Pillsbury (New York)	½
A. Burn (Liverpool)	0	J. W. Showalter (New York)	1
H. Caro (London)	0	J. H. Barry (Boston)	1
H. E. Atkins (Leicester)	½	E. Hymes (New York)	½
G. E. H. Bellingham (Dudley)	0	A. B. Hodges (New York)	1
D. Y. Mills (Edinburgh)	1	E. Delmar (New York)	0
C. D. Locock (London)	½	D. G. Baird (New York)	½
E. M. Jackson (London)	1	F. K. Young (Boston)	0
Herbert Jacobs (London)	1	A. K. Robinson (Philadelphia)	0
H. W. Trenchard (London)	1	J. A. Galbreath (New Orleans)	0
	5½		4½

A brief description of each game is appended. The American players had the move at boards 1, 3, 5, 7, and 9.

No. 1.—Mr. Blackburne, in defending the Queen's Gambit, obtained an inferior game, and was compelled to give his opponent the advantage of a passed Pawn. After many fruitless attempts to utilize his advantage, Mr. Pillsbury, most unselfishly playing to the score, gave up his best Pawn on the chance of a win. In the end Mr. Blackburne was a Pawn ahead, but this was probably insufficient to win.

No. 2.—Mr. Burn obtained a slight advantage in a close game, but after nearly all the pieces were exchanged, Mr. Showalter made a most brilliant combination out of the small material left, the sacrifice of a piece leaving him ultimately with two Pawns to the good and a won game.

No. 3.—Mr. Caro disregarded his opponent's King's side advance in a close game, and obtained a (perhaps) winning advantage on the Queen's side; but he overlooked a most ingenious saving and winning resource, and was compelled to resign.

No. 4.—Mr. Atkins obtained a slight advantage in a French Defence (2. Q to K2), but the sacrifice of a piece did not turn out so well as he expected, and he was glad to have an opportunity of giving perpetual check.

No. 5.—Mr. Bellingham, defending the "close Ruy Lopez," found himself under a violent attack. He defended himself with great care and patience, and most of the pieces were exchanged; but the attack came again with Q and R on each side, and the Black Pawns could not be saved.

No. 6.—Mr. Mills had not much difficulty in disposing of the eccentric variation of the French Defence played by his opponent. He won the exchange first, and then the game, having only to steer clear of a few traps.

No. 7.—Mr. Locock's Two Knights Defence was promptly converted into a Giuoco Pianissimo. Black obtained a slight advantage early, but was unable to prevent the exchange of all the minor pieces. White after that should have made some desperate attempt to win or lose (a draw being useless to his side), but neither side attempted anything, and the position at the end of the second day was practically the same as at the end of the first.

No. 8.—Mr. Jackson waited until his opponent had finished his eccentric development in a French Defence, and then proceeded to take vigorous advantage of the various flaws in his opponent's position, winning first the Queen and two Pawns for Rook and Knight, and afterwards what he liked.

No. 9.—Mr. Jacobs played P to KB4 in answer to 1. P to Q4. His opponent injudiciously exchanged the centre Pawns, thereby freeing Black's game for an attack on the King's side. Mr. Jacobs won a Pawn, and the Bishops of opposite colours made winning all the easier. The actual process chosen was very pretty, Mr. Jacobs sacrificing the exchange in an end game in order to permanently block in his opponent's Rook.

No. 10.—Mr. Trenchard attacked a little prematurely on the King's side in a close game. His opponent weakly blocked the Queen's side, and afterwards sacrificed the exchange rather unnecessarily. After that Mr. Trenchard picked up Pawns till his opponent resigned.

The Inter-University Match was played at the British Chess Club on March 25th. The following is the score :—

Oxford.		Cambridge.	
E. G. S. Churchill (Magdalen)	0	C. E. C. Tattersall (Trinity)	1
E. R. W. George (New College)	0	L. McLean (King's)	1
A. P. L. Hulbert (Keble)	1	H. G. Softlaw (Trinity Hall)	0
A. H. Currie (Brasenose)	1	A. Fotheringham (Emmanuel)	0
F. Soddy (Merton)	½	A. W. Foster (St. John's)	½
F. A. Babcock (Wadham)	½	R. S. Makower (Trinity)	½
L. T. Dodd (Merton)	0	H. R. Cullen (Caius)	1
	3		4

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